LUMBER PROTECTION

IN THE

90's

Forintek Canada Corp.
Western Laboratory

LUMBER PROTECTION IN THE 90'S

Proceedings of a meeting held at:

FORINTEK CANADA CORP.
Western Laboratory

January 31, 1991

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PREFACE

On January 31st, 1991, Forintek Canada Corp. sponsored a meeting at its Vancouver laboratory. The meeting was in response to the recent increase in the number of sapstain control products being registered and becoming industrially available. The producer of each registered product was invited to present a 15-20 minute update on that product at the meeting. Questions/comments followed many of the presentations. In the afternoon producers of products which were in the registration pipeline were given a similar opportunity to present information on their products.

For this publication the presenters were invited to send a 500 - 1000 word summary of their presentation. The products of this request are contained herein. The content of these statements is entirely the responsibility of the companies providing the statements. The reference to trade names or commercial products in this report does not constitute endorsement or recommendation for use by Forintek Canada Corp.

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INTRODUCTION TO LUMBER PROTECTION SEMINAR

Bob Stephens
Vice President
Western Region

Forintek Canada Corp.

Good morning ladies and gentlemen:

My name is Bob Stephens, and I am Vice-President of Forintek's Western Division. It is my distinct pleasure to welcome you today and I must say that it is most gratifying to see such an excellent turnout for our seminar on lumber protection in the 90's.

The last time we saw our Assembly Room filled to capacity on this subject was six years ago when we held a meeting to determine whether there was indeed to be life after pentachlorophenol. I am sure many of you recall the events leading up to Reichhold's sudden withdrawal in 1985 from the chlorophenol business. Since then, there has been tremendous progress. There are virtually no chlorophenates being used for lumber protection and it is gratifying to see that several of the chemicals that were reported on at that meeting in 1985 are now in regular use by the forest products industry in British Columbia.

Apart from the time lapse and the subject matter, the other significant difference about today's meeting is that I am able to talk to a much larger audience due, of course, to the fact that we have moved into our magnificent new building.

We are extremely proud of our new laboratory which is a living demonstration of the fact that wood can be used cost-effectively to construct large, multi-occupancy buildings.

For those of you interested in statistics, the structure contains approximately 105,000 square feet and includes 464,000 board feet of dimension lumber, 130,000 board feed of glulam beams, 412,000 square feet of plywood, 46,000 lineal feet of truss joists, and 6,000 cubic feet of Parallam beams. This laboratory has used as much wood as a good-sized residential subdivision. The plywood alone would sheath all roofs, exterior walls and above-grade floors for more than 40 two-story single family homes. End to end, the truss joists would stretch from here to North Vancouver and the largest sawmill in Canada would have to operate for two full shifts non-stop to produce lumber that has been used in this building. However, apart from these dramatic numbers, the most significant point demonstrated by this building is that the use of wood instead of steel for the structure reduced the overall cost by 30%. I think you will agree that we are surrounded by living proof of the fact that "Wood Works" in industrial construction.

Another important aspect of making wood work is wood protection technology and that is why we are here today. Wood protection has become vitally important at a time when industry must strive for new export opportunities in the face of growing environmental concerns. Therefore, the purpose of our seminar today is to provide you with up-to-date knowledge of the current situation, a status report on currently-registered products, a glimpse at the next generation of environmentally-friendly systems currently under development, and finally, an update on the registration scenario.

Once again, welcome to our new laboratory, welcome to our seminar. I would now like to introduce to you Roger Smith, Manager of our Treated Wood Department, who will open up today's proceedings by telling you about LUMBER PROTECTION TODAY.

Thank You.

LUMBER PROTECTION TODAY

Roger S. Smith
Manager, Treated Wood

Forintek Canada Corp.

Introduction

Lumber, being a naturally biodegradable product, is always vulnerable to attack by biological organisms, which can cause its degrade and loss in value. Fungi of various kinds can grow both over and inside lumber, resulting in very unsightly stains and often decay.

To prevent attack by sapstain, mould and wood-destroying fungi, lumber is protected by the application of chemical pesticides called sapstain control products. The benefits of using such treatments in B.C. have been estimated to be at least $388 million per annum. Failure to protect lumber would result in product quality claims leading to price discounts and the possible loss of export market share. In Canada during 1988 it is estimated that about four billion board feet (10 million m^3) of softwood lumber, valued at over two billion dollars, was chemically protected using various antisapstain formulations.

Chemical wood protection is practised by lumber producing countries worldwide. In North America the volume of softwood lumber treated with antisapstain formulations is about 15 million m^3, this probably representing about 50% of the volume treated worldwide.

LUMBER TREATED vs PRODUCTION

(MILLION m^3)

	CANADA	JAPAN	USA	FINLAND	NEW ZEALAND	CHILE	SWEDEN
LUMBER TREATED	10	7	4.5	3	2	2	1
LUMBER PRODUCTION	60	30	90	8	2.5	3	11

The amount of antisapstain chemicals used is difficult to determine, but within Canada it has been calculated at about 1,100 tonnes (1) and worldwide it could be in excess of 5,000 tonnes. The value of this antisapstain pesticide market in Canada is about $16 million, which is only a fraction of the total pesticide market worldwide of $20 billion.

The number of chemicals available to the Canadian lumber industry has increased considerably in recent years, with the following nine products now registered:

Product	Active Ingredient
Busan 30	TCMTB
Chapco SA-1	DDAC + IPBC
Ecobrite	Soda + borax
F-2	DDAC + borax
NP-1	DDAC + IPBC
Nytek GD	Cu-8 quinolinolate
PQ-8	Cu-8 quinolinolate
Rodewood 200EC	Azaconazole
Timbercote	DDAC + latex

This represents a large increase from a decade ago when the lumber industry was heavily dependent on chlorophenates for the protection of its lumber. Both pentachlorophenate and tetrachlorophenate had been the mainstay of our lumber protection industry in North America for over 50 years. However, the discovery of dioxins in these formulations resulted in their ultimate abandonment, although, their efficacy in controlling sapstain, mould and decay fungi on lumber was superior to most products in use today. It is interesting to note that the constituents of many of the "new" products, such as soda, boron, copper-8 and TCMTB were identified as useful antisapstain chemicals many decades ago but remained largely underdeveloped because of the availability of highly effective and relatively cheap chlorophenates.

In other lumber manufacturing countries a much wider range of chemical formulations is generally available to protect lumber. For example, in New Zealand and some European countries methylene bis thiocyanate can be used. This chemical has been tested by Forintek and found to be excellent at protecting wood, particularly when combined with TCMTB (2). However, the chemical is not viewed with enthusiasm by Health and Welfare Canada and it is unlikely to be approved for use in Canada.

This brings up the question of product registration in Canada and its implementation by Agriculture Canada. Worldwide we seem to have developed the reputation for being an "impossible" country when it comes to pesticide registration. However, the protection of our land, seas and rivers, as well as the people living in Canada, must be of paramount importance and the safety of pesticides to be used by our lumber industry must be soundly based. For this reason Forintek has placed increased emphasis on those formulations containing environmentally friendly chemicals, such as borax, soda, quaternary ammoniums (for example DDAC) and triazoles (for example azaconazole and hexaconazole).

The possibility of kiln drying all export lumber has been suggested as an alternative to the continued use of chemicals. This has recently been given greater emphasis by the proposed importation ban on unseasoned lumber in 1992, initiated by the European Communities

(E.C.). The basis of this is phytosanitary in nature and is meant to prevent the possible importation of the pinewood nematode and its vector sawyer beetle into the E.C. countries.

Should we be required to kiln dry all export lumber to the E.C. the cost would be enormous. It has been estimated (3) that a volume of 1,092,000 Mfbm/year would be involved, using an extra 62 kilns at a capital cost of $187 million with an annual operational cost of $100 million. Clearly this would be an onerous undertaking for our industry at this time, and some alternate solutions are under consideration. However, it does exemplify the enormous cost differential between kiln drying lumber ($50-100/Mfbm) and the use of antisapstain formulations ($4-8/Mfbm).

Apart from the high cost considerations, I do not believe kiln drying lumber will automatically remove the necessity for chemical treatments, as is often suggested. Mould fungi can grow at relatively low relative humidities and it could be extremely difficult to ensure that every piece of lumber has been adequately dried and would remain so for the entire period of transit and storage to the customer. I would suggest that chemical protection for lumber will remain our main insurance policy against fungal degrade and we should learn to live with it and use it effectively.

During my preparations for this meeting today and introduction to the real meat of the program, which follows my paper, I was struck by the enormous progress the lumber industry of Canada has made over the last decade in the area of lumber protection. Too often our attention is drawn to the negative aspects of our industry and we fail to respond and take pride in the positive advancements that we make collectively. I would like to review some of these with you under the headings of improved formulations, efficient application and quality assurance.

Improved formulations

It should be remembered that the move of our industry away from the dioxin containing chlorophenates began several years ago, at about the time that these chemicals were banned from use in Sweden, and it illustrates the progressive and forward looking nature of our lumber industry. Today we have moved to more benign chemicals while most other countries continue to allow the use of chlorophenates. The unfolding potentially hazardous nature of dioxins to our environment and work force triggered a response from the lumber industry to search for safer alternatives. It is worthwhile, just for a moment, to consider the toxicities, by ingestion, of some common chemicals. The toxicity of borax is similar to table salt (sodium chloride) and is fifty times less toxic than pentachlorophenol which has similar toxicity to nicotine.

CHEMICAL TOXICITY

	LD_{50} by ingestion
Chlorothalonil	> 10,000 mg/kg
Sodium chloride	3,000
Borax	2,500
DDAC	450
Pentachlorophenol	50
Nicotine	50
Ricin	0.000001

DDAC is about nine times less toxic than pentachlorophenol, while ricin, the chemical favoured for political assassinations, is about one billion times more toxic than the newer antisapstain formulations.

Today we have chemicals which are more user friendly than the chlorophenates. An excellent example is Ecobrite, containing borax and soda. Other examples are those formulations containing DDAC or Copper-8 quinolinolate, which have low mammalian toxicities and are free of dioxins.

Concern for the environment remains a constant issue for our industry, and because of the location of many sawmills adjacent to rivers and the oceans, this translates into concern for aquatic plant and animal life. When developing new formulations for lumber, fish toxicity is now a consideration of high priority. This concern can be illustrated by the recently instituted Antisapstain Waste Control Regulations approved under the Waste Management Act by B.C. Department of Environment in 1989. This act established limits in stormwater effluents for the first of the following three chemicals, with the last two being added subsequently:

Chlorophenols	:	6 ppb
TCMTB	:	15 ppb
Cu-8	:	15 ppb
IPBC	:	120 ppb
DDAC	:	700 ppb

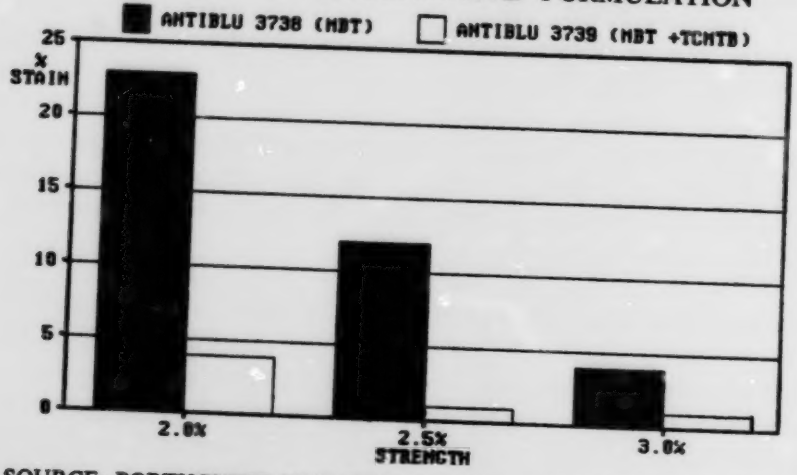
These values are derived from the known fish toxicity values for these chemicals together with consideration of safety factors for acute toxicity, environmental fate, degradation and metabolic hazards and finally dilution. While these regulations are proving difficult for the lumber industry to meet, there can be no doubt that their enforcement can only benefit our environment in the long term. The reduction of chemical wash-off from protected lumber is being considered by many chemical suppliers using such technologies as pesticide

encapsulation, the use of "stickers" and other adjuvants in formulations to increase their adherence to wood, and also by Forintek (4), Walker Brothers and ICI Chipman, in the development of ultra-low volume, charged-drop, application technology.

Lastly in this area I want to comment on the move towards multi-active formulations, that is the combination of more than one pesticide in a formulation. This has become critical as the pesticide industry moves away from broad spectrum pesticides (e.g. chlorophenates) to target specific chemicals (e.g. triazoles). In our industry we need to control a very large range of fungi, from simple moulds, to more complex wood-destroying basidiomycetes. The latter fungi are generally well controlled by triazoles, but such pesticides are unfortunately not very active against some mould fungi, like *Trichoderma*, which disfigure lumber. Borates are similarly very effective against decay and certain staining fungi, but are unable to control some staining fungi like *Alternaria*.

Therefore, multi-active formulations which combine borates with other pesticides (e.g. DDAC) have greater chance of success in the marketplace. This can be illustrated by the work of Lewis, Williams and Eaton in 1985 (5), who were trying to control bluestain on maritime pine in Portugal. By substituting half of the amount of MBT in Antiblu 3738 with TCMTB (Antiblu 3739), they achieved greatly enhanced control activity.

BENEFITS OF MULTI-ACTIVE FORMULATION



SOURCE: PORTUGUESE PINE STUDY (LEWIS, WILLIAMS, EATON, 1985)

One further advantage of multi-active formulations concerns the possibility for adaptation by fungi to individual pesticides. Should resistant strains of fungi become a possibility, then those formulations containing more that one chemical would have a larger potential usefulness to our industry. Very recently evidence is coming from New Zealand which would support the theory of fungi developing resistance to antisapstain chemicals on lumber, which suggests that reliance on single active ingredients may not be the best insurance (6).

Resistance can be thought of as an extension of the natural tolerance shown by some fungi

towards specific chemicals. This can be seen from laboratory toxicity studies done on F2 (Figure 1), and TCMTB (Figure 2), where *Trichoderma pseudokoningii* in the former and *Ceratocystis piceae* in the latter case, show greater tolerance to the antisapstain formulation than the other test fungi. This fungal resistance must be understood before successful multi-active formulations can be developed.

Efficient application

In this area of protection, more than any other, Canadian sawmills are world leaders. They pioneered the use of highly efficient spray systems, moving away from various dip systems with their high potential for environmental hazard. Using both longitudinal and latterly, transverse spray booths, Canadian mills have striven to achieve uniform lumber coverage with target quantities of antisapstain formulations. Equipment suppliers, such as Diachem Industries and Walker Brothers, have developed sophisticated spray systems which serve the needs of a lumber industry determined to protect its lumber while reducing environmental hazards in the workplace.

Increased spray pressures were tested and are now used to produce spray clouds with smaller droplets, giving better coverage and less wetting of the wood surface. The latter became an important need to protect graders and subsequently handlers of the treated lumber. The relationships between fluid flow rate, spray pressure and lumber speed are now understood by most sawmills, enabling the required surface retentions of antisapstain formulations to be achieved on a continuous basis.

New self-cleaning nozzles, designed and built by equipment suppliers, have greatly reduced the problems associated with nozzle pluggings and spray failure. Whereas previously it almost seemed impossible to maintain spray boxes with all nozzles consistently spraying, todays nozzles have made that a reality.

By using double-chambered spray boxes, the problem of environmental overspray in the sawmill has been greatly reduced. This, together with careful metering, filtering and recycling of antisapstain chemicals, has also reduced the volume of toxic waste developed by sawmills in Canada today. This situation contrasts sharply with operations in other countries, for example in the U.S. and New Zealand (7), where technology generally lags far behind that used in Canada.

In 1986 Forintek decided to search for even greater improvements in spray design efficiency and operation. This has led to the experimental development of Electrodyn-type, charged-drop, spray systems. Both the Electrodyn (8) (ICI patented) and Totalstat (9) (Terronics patented) have been tested in Forintek's linear, spray, laboratory and both show potential for ultimately replacing the existing lumber spray systems. Charged drops of antisapstain solutions in oils can be applied to moving lumber with high transfer efficiencies of close to 90%. This could mean the virtual elimination of solution recycling and environmental

Figure 1

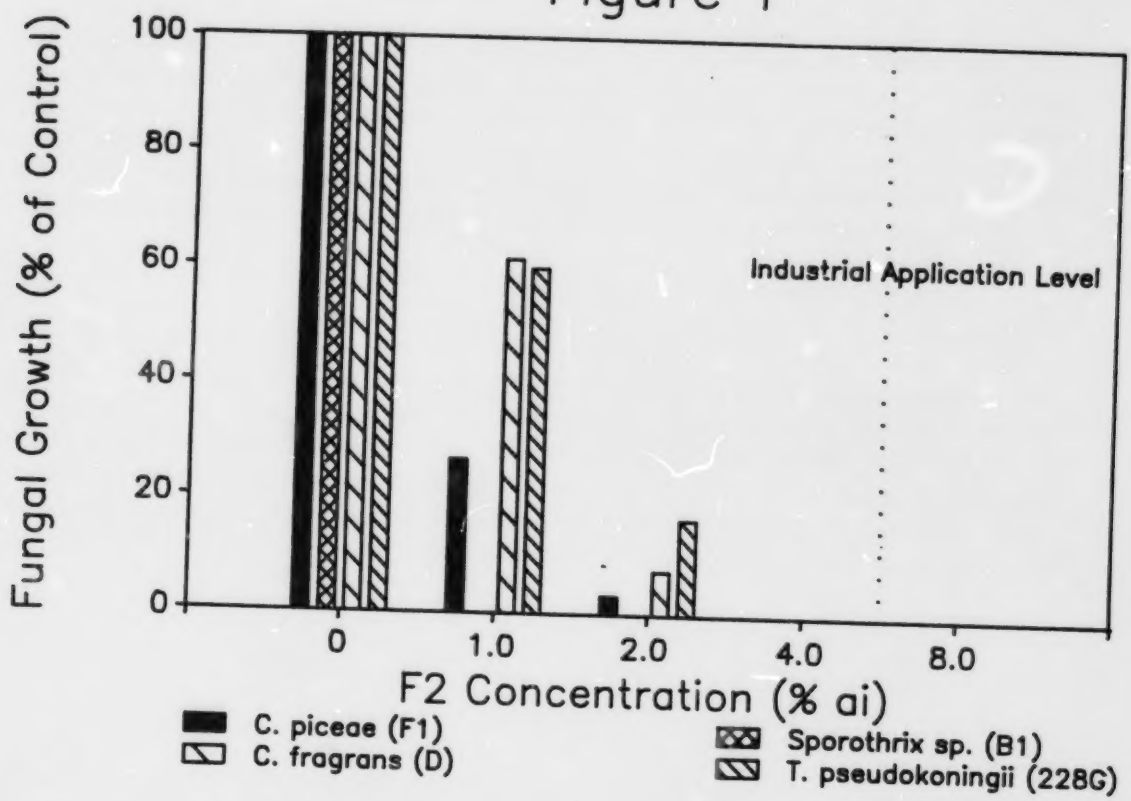
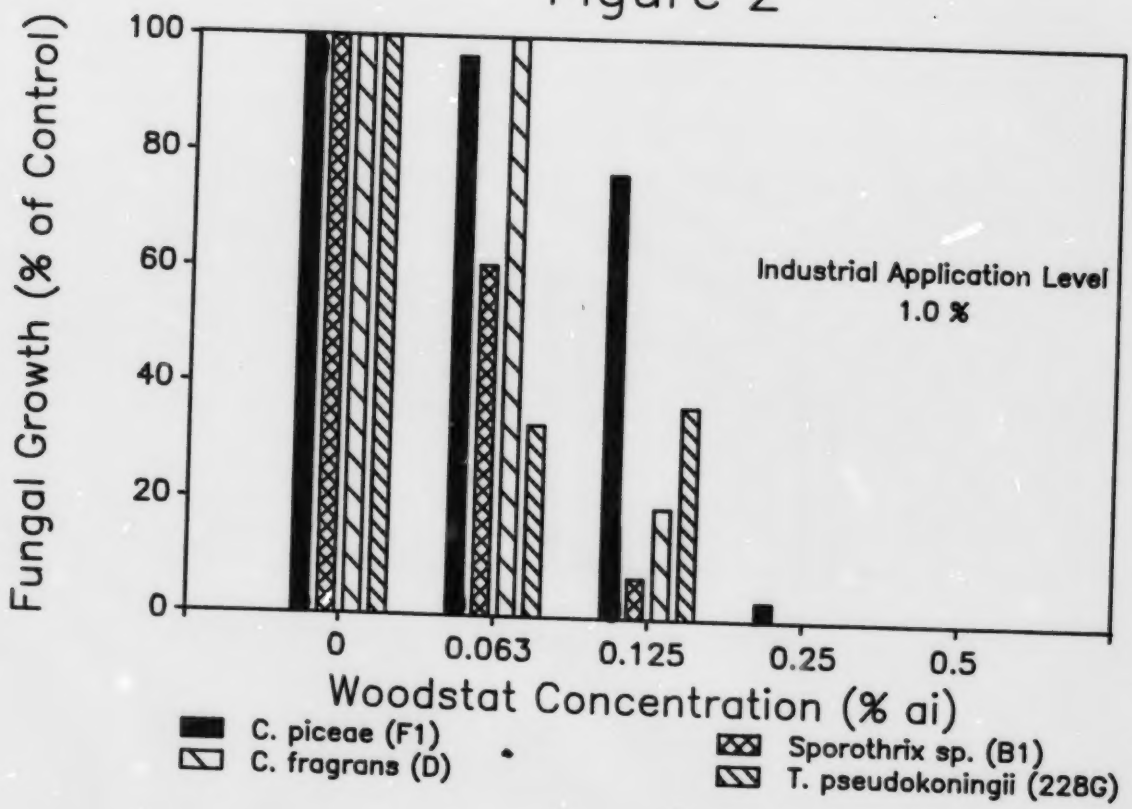


Figure 2



problems related to overspraying. The costly and difficult to maintain, filter systems currently used by all sawmills using spray systems would become obsolete, thereby creating environmental benefits with accompanying financial savings.

Such visions for the future of our industry may be rapidly approaching reality, fuelled by the imperatives contained in the Government of Canada's recently released Green Plan.

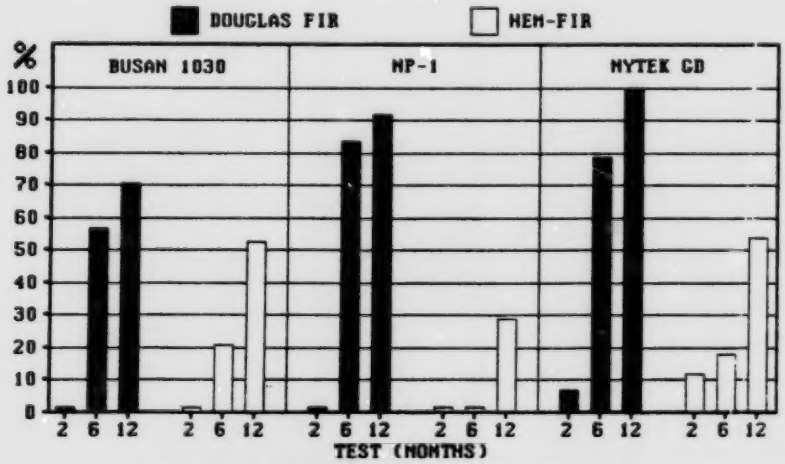
Quality Assurance

This must represent a vital defense procedure for our industry. The quality of antisapstain application should be measured by the uniformity of chemical distribution on the lumber and its proximity to the required target retention. The latter is established by carefully controlled efficacy testing using field exposure situations and full-size lumber samples of various species. Such testing is done by Forintek routinely, which has resulted in the following retentions being accepted by industrial sawmills:

TCMTB	40 $\mu g/cm^2$
PQ-8	5-10 $\mu g/cm^2$
Nytek	15-20 $\mu g/cm^2$
F-2	200 $\mu g/cm^2$

Variation between commercial wood species groups and their susceptibility to fungal attack, must be understood and allowances made in the retention targets for each formulation. To exemplify this problem the recent work of Miller (10) clearly shows the extreme susceptibility of Douglas fir sapwood studs to staining fungi when compared to hem-fir. This indicates the necessity for higher retentions of antisapstain formulations for the sawmill producing Douglas fir lumber for export.

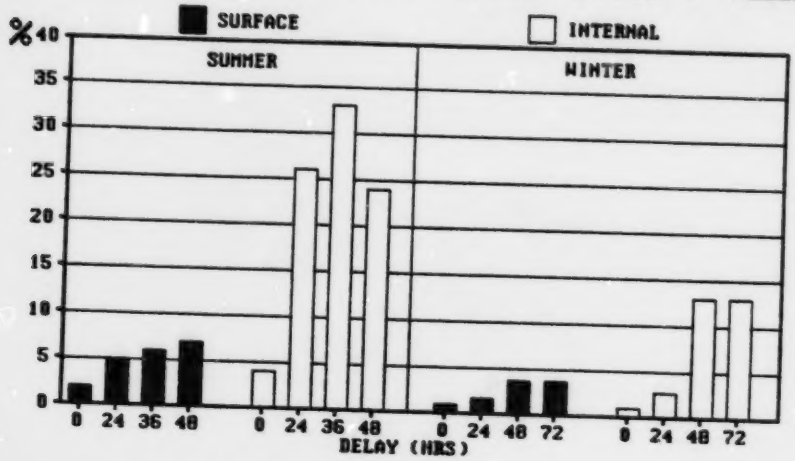
STUDS EXTENSIVELY STAINED (%)



SOURCE: CORVALLIS STUDY (MILLER, 1990)

A further consideration for the sawmill concerned with quality assurance must be the season of operation and the time period between sawing and application of the protective chemical. Both of these factors can be illustrated from the work of Verrall and Mook (11) on southern pine. In this study the higher summer temperatures create an increased hazard for internal stain which becomes uncontrollable after a treatment delay exceeding less than 24 hours in the summer and between 24 and 48 hours in the winter.

STAIN DEVELOPED ON LUMBER AFTER 5 WEEKS



SOURCE: MISSISSIPPI STUDY (VERRALL & MOOK, 1951)

These two factors are a problem for many interior B.C. sawmills, which ship their sawn lumber to the coast for antisapstain treatment. The incurred delay in treatment resulting from this practice puts their export lumber packages at high risk for deterioration by mould, staining and decay fungi. Efficient chemical treatment at the sawmill remains the best and only reliable form of protection for unseasoned export lumber.

In 1987, as a vital service to member sawmills using sapstain control products, Forintek established the Antisapstain Quality Assurance Program which provided a snapshot in time of the spraying (or dipping) efficiency of a mill. Working initially with chlorophenates, but now also with TCMTB, PQ-8 and Nytek, Forintek can supply its member mills with a reliable estimation of the average chemical retention on its lumber production. Monthly samples are evaluated throughout the year, thereby providing an on-going review of treating procedures and allowing sawmill operators to take the action to meet the necessary surface retention requirements for the antisapstain chemical in use.

Such a quality assurance scheme has proven beneficial to the lumber industry as indicated by the improved average retentions shown for both chlorophenates and TCMTB for B.C. coastal production from 1987 to 1989.

ASQAP RESULTS 1987 - 1989
AVERAGE MICROGRAMS/cm^2
(SAMPLE NUMBER IN BRACKETS)

Chlorophenates	January - June 1987	July - December 1987
	45 (1,196)	65 (1,440)
TCMTB	January - June 1989	July - December 1989
	44 (1,860)	54 (2,938)

This information has meant the export of less lumber at risk from mould, stain and decay and also it has helped prevent the over-use of chemicals, which could pose a hazard to the environment.

Conclusions

My overall conclusion, when I look at lumber protection today in Canada, is one of pride in an industry that, being faced a decade ago with a serious problem, seized the initiative and came up with some viable solutions. We have removed chlorophenates from our mills, we are using more environmentally and user friendly antisapstain formulations, we have greatly improved our application technology and lastly we have quality assurance methods in place to ensure that we are doing the job properly. Our lumber industry has the tools to lead the world in chemical protection technology and that means that Canadian lumber should take second place to none other in the market place around the world.

However, environmental regulations will increasingly impact on sawmill operations and new technologies will be required to meet these controls. I am confident that our industry, together with expert input from chemical suppliers, equipment manufacturers and Government agencies, will meet the challenges of the 90's to maintain our pre-eminence in this vital aspect of lumber production.

Acknowledgements

I am greatly indebted to the excellent research done at Forintek over the past eleven years by my colleagues within the Treated Wood Department. Without them this paper would not have been possible and our knowledge of this subject would have been considerably poorer. I thank them all.

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3. Review of Registered Sapstain Control Products

Moderator: Dennis Konasewich, Envirochem Services

TCMTB UPDATE

Brian LaJambe
Western Regional Manager

Buckman Laboratories of Canada Ltd.

TCMTB [2-(thiocyanomethylthio)benzothiozole] products have been successfully protecting British Columbia lumber from sapstain and mold for 4 1/2 years.

The two products used are based on 30% active TCMTB. One is a solvent-based formulation (ie. BUSAN 1030) and the other is a water-based formulation (ie. BUSAN 30WB).

In addition to direct sales under our BUSAN trade name, we have made these formulations available in British Columbia through Diachem and Walker Brothers, under their own trade names.

It has been firmly established that 40 $\mu g/cm^2$ TCMTB on the surface of lumber will protect freshly-cut wood for a period of over 12 months. For SPF and Hemlock, adequate protection has been achieved in some instances at levels of 20 - 30 $\mu g/cm^2$. Douglas Fir has generally required levels in the 40 - 50 $\mu g/cm^2$ range.

Treatment costs will vary according to method and surface-area covered; however, 40 $\mu g/cm^2$ of TCMTB (spray application) will usually range from $2.50 - $3.50/Mfbm.

The few stain problems brought directly to our attention were inspected on location by our overseas Technical Specialists. Investigation showed these problems to be either enzymatic (iron-staining) or due to insufficient TCMTB coverage (ie. levels below 15 - 20 $\mu g/cm^2$).

The fact that TCMTB can be accurately measured on the surface of wood by straight forward HPLC (High Performance Liquid Chromatography Method) has provided a benefit from a lumber quality control standpoint. Mills using TCMTB have been able to take advantage of Forintek's Anti-Stain Quality Assurance Program (i.e. ASQAP).

A recent study has shown that TCMTB provides good above-ground mold and decay protection of wood for up to 10 years.

Three significant problems have been encountered with TCMTB sapstain control applications in British Columbia :

1) Skin irritation / worker sensitivity;

2) Cold weather handling problems (with the water-based 30WB formulation);

3) Stormwater runoff (impact on fish toxicity);

1) Skin irritation / worker sensitivity:

The irritation properties of TCMTB established a need for the Lumber Industry to improve traditional spray system design and industrial hygiene practices.

Considerable progress has been made by the industry to improving the standards of anti-sapstain chemical use.

Through BUCKMAN's commitment to the safe and effective use of TCMTB, we have provided assistance in achieving improvements of reduced worker exposure in the areas of: a) Protective clothing; b) Spray system engineering; c) Safe handling education; and d) Product formulation, to provide better runnability.

Exposure of maintenance workers continues to be a problem area in cleaning and maintaining spray boxes; especially, large transverse boxes.

BUSAN 1118 was developed in 1988 as a further improvement in product formulation to insure trouble-free spray applications, with minimum maintenance.

An application for registration of this relatively minor formulation change was filed with Agriculture Canada 2-years ago. Unfortunately, it is still not registered for use.

In addition to BUSAN 1118, an extensive research program has been undertaken by BUCKMAN to microencapsulate TCMTB to minimize irritation properties. Field test work with microencapsulated TCMTB should take place within the next several months.

2) Cold weather handling problems with water-based busan 30wb formulation:

In cold weather (< 10°C), BUSAN 30WB thickens as a water-emulsion and can start to have crystals of TCMTB form. This creates pumping problems, screen and nozzle plugging. Newer spray systems have been designed to minimize these problems and the resulting maintenance worker exposure.

BUCKMAN has committed the necessary manpower and material resources to affect a much improved co-ordination between product order and delivery. This service has helped to bring 30WB transfer problems under control.

The BUSAN 1118 formulation has been designed to be stable in cold weather (no crystallization nor pumping problems). As previously stated, BUSAN 1118 will be available

as soon as it is registered for use by Agriculture Canada.

3) Stormwater runoff:

Existing British Columbia Provincial Legislation states that from September 1, 1990 until September 1, 1991, the concentration of TCMTB in effluent shall not exceed 15 ppb, based on the lowest recorded 96-hour LC50 for fish species. From September 1, 1991 the concentration of TCMTB in effluent shall not exceed 6 ppb.

Straight forward analytical methods have been developed to detect TCMTB levels in stormwater runoff down to below 6 ppb. This allows the lumber mill to quickly determine stormwater levels and to know where they stand.

In general, mills to date have not been able to consistently meet these stringent stormwater runoff limits. Stormwater runoff levels at mills using TCMTB have ranged from below 15 ppb to above 200 ppb.

Our efforts in this problem area have focused on improved fixation of TCMTB to the surface of lumber.

We have established that the rate of leaching is significantly dependent on the type of TCMTB formulation used. One modified formulation (ie. BUSAN 1118) has been shown to reduce the rate of stormwater leaching 30 - 50% over BUSAN 30WB. Ongoing test work has indicated that we can substantially further-reduce the rate of leaching by using either chemical or mechanical fixing agents.

Our ultimate goal is to achieve zero discharge (ie. below detectable levels).

BUCKMAN LABORATORIES remains committed to completing the full Agriculture Canada Toxicological Data Package. This commitment was made voluntarily in 1985, prior to the antisapstain review.

All outstanding long-term studies are scheduled to be complete and submitted to Agriculture Canada by mid-1991.

ECOBRITE SUMMARY

Terry Stigings
Vice-President Technical Services

Diachem Industries Ltd.

Ecobrite, can be described as an environmental breakthrough in the forest industry particularly as it relates to SPF production.

It is the first antistain product for lumber that

- works effectively
- does not harm the environment
- is safe to those who apply it
- and is completely safe when the lumber is used by
  - the home builder
  - the cabinet maker
  - and anyone else who uses treated lumber.

Most lumber destined for distant markets is treated with antistain products to stop the growth of mould which stains the wood. This is particularly important for B.C.'s growing lumber export market.

The differences between Ecobrite treated and untreated lumber shipped to Japan were noted in 1986. After 7 months storage, the Ecobrite treated was in excellent condition while the untreated product was unacceptable.

While there is no question that most lumber must be treated with an antistain product, particularly for export, there have been a variety of environmental issues connected to antistain treatments.

1. Air Emissions

There are no air emission concerns with Ecobrite. Other antistain products unfortunately are subject to stringent air regulations.

2 Leachate Standards

Water contamination, especially from runoff has often been a problem with antistain treatments. Water runoff, or leachate is not a problem with Ecobrite.

To determine the leachate standard, fish are placed in water containing the chemical to be measured. After 96 hours, the number of surviving fish is used to calculate toxicity. The

leachate standard is recorded in parts per billion.

As can be seen from the following chart, Ecobrite has extremely low fish toxicities and, therefore, is the only product which is not regulated by the Government.

FISH TOXICITY DATA		
ANTISAPSTAIN CHEMICAL	96 HOUR LC50 PPB	SPECIES
TCMTB	39 15	Rainbow Chinook
Copper-8	23 16	Rainbow Chinook
Ecobrite	**502,000**	**Rainbow**
Azaconazole	22,000 24,000	Rainbow Chinook
NP-1	1,300 1,080	Rainbow Chinook

What this means is that using Ecobrite you will never run the risk of being in non-compliance with Government regulations and as the only non-toxic antistain, Ecobrite is the environmentally sound choice.

3. Wood Waste

Ecobrite treated wood waste can be recycled or disposed as a standard waste.

Wood waste containing other antistain treatments is a highly regulated material requiring special on-site storage or other special treatment methods.

4. Health and Safety

The health and safety of wood working employees is an area of special concern and antistain treatments have posed a potential problem. In evaluating workplace safety, there are two areas of concern:

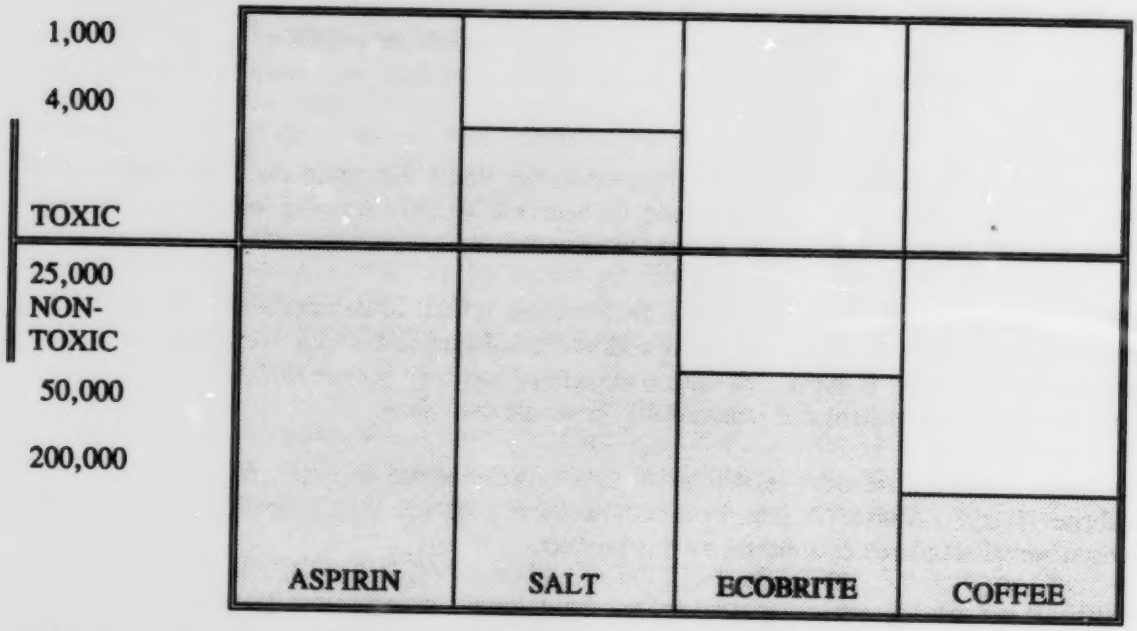
- acute or immediate problems
- possible long term or chronic problems

When we compare Ecobrite to substances common to the home, we find that Ecobrite is 50 times less dangerous than Aspirin, 12 times less dangerous than salt and only 4 times more

dangerous than coffee.

The numbers on this graph represent the LD50 values for these products, which is the standard measurement of toxicity to humans. LD stands for lethal dose and measures milligrams of substances to kilograms of weight. The line at 25,000 is the point considered to be non-toxic. It's important to remember that these measurements represent the worst possible case, in other words, ingesting the product.

RELATIVE TOXICITY



Ecobrite is a mixture of natural materials which do not break down. Which means there are absolutely no workplace health or safety issues connected to Ecobrite.

The Federal Government's WHMIS Program rates Ecobrite as "one", on a scale of 0-5 with 0 being water. This means only basic safety measures, such as gloves and aprons, are required when handling the product.

Efficacy

There are essentially two methods for preventing the growth of mould on lumber. All other antistain products are designed to kill the mould. Ecobrite takes a new approach. It prevents the mould from growing by creating a barrier between the wood and the mould or fungi. Ecobrite is a mixture of simple inorganic materials -- Borax and soda ash, which can be found in many common household products. It coats the lumber preventing mould and fungi from

reaching the food source.

Tests done by Forintek compared several antistain treatments on SPF lumber shipped from Prince Rupert through the Panama Canal to the United Kingdom. (Appendix A - at end of Ecobrite report). Seven months from production, the inspection of each package showed that Ecobrite was one of only two products which provided acceptable protection. and only Ecobrite is non-toxic. (Appendix B - at end of Ecobrite report) This graph shows SPF shipments to Tokyo. As you can see, Ecobrite treated SPF provides good levels of protection, which the control group - non-treated green SPF - does not provide acceptable protection. (Appendix C - at end of Ecobrite Report) Ecobrite also significantly increased protection on kiln dried SPF lumber.

(Appendix D - at end of Ecobrite Report) This graph shows the results of storage trials for hemlock over 4 and 11 months. In this instance, the product was considered to be very acceptable.

Our experience in the development of this product has found that when Ecobrite is applied to SPF, a natural colour results. When used on hemlock we have found a variation of colour. This colour change has also shown up on Douglas fir.

It was recognized that the appearance of hemlock and fir had to be improved. An extensive research program has found an acceptable additive called Eco-xtra which overcomes the colour variation of hemlock. However, this additive material has been proven difficult to apply. The result has been inconsistent and unacceptable coverage over time.

Additional products are now in the registration process aimed at improving this condition. Ecobrite II and Ecobrite IV are modified Ecobrite products which continue to meet the environmental standards established by this product.

In summary, Ecobrite is a non-toxic antistain. In fact, it is the only non-toxic antistain on the market and that means:

- It poses no workplace health and safety risks;
- It is non-regulated by Government which removes the worry of users being in non-compliance with Government regulations;
- And as a non-toxic antistain, Ecobrite is environmentally friendly - something which is increasingly important to all of us.

It is these qualities which resulted in Ecobrite being awarded the 1989 Silver Trophy in the Invention Category of the Canada Awards for Business Excellence.

F-2

Gerald Davis
General Manager

Walker Brothers
Division of the Glidden Company (Canada) Ltd.

F-2 is an emulsion concentrate containing two very effective antimicrobial agents, didecyldimethyl ammonium chloride (DDAC) and disodium octaborate tetrahydrate (Borax) which combine to provide a full spectrum of coverage against moulds and decay fungi and so provide lumber with outstanding protection.

This product evolved from a research and development program initiated by Forintek several years ago, aimed at developing a high performance, low environmental impact antisapstain agent. The F-2 technology was subsequently licensed by Walker Brothers who have since formulated and registered F-2 concentrate.

Field evaluation tests (12 months) conducted by Forintek show that F-2 performance is comparable to the industry high quality standards established with chlorophenates and these results have been confirmed by mill trials conducted at Primex, Acorn Division and Doman's Vancouver Division.

Like all DDAC formulations F-2 is worker unfriendly in that it is a severe contact toxicant and accordingly the Code of Good Practice must prevail at all use stations. Fortunately, it is only a mild systemic toxicant and all indications are that it has no long term health effects.

The fish bioassay results for F-2 give readings for 96LC(50) of 3.2 and 3.9 ppm for Chinook Salmon and Rainbow Trout respectively making it the lowest aquatic impact, high performance antisapstain agent in use today.

F-2 overall has favourable environmental impact parameters and accordingly the regulations for allowable concentrations in water run-off have been set at 700 ppb for DDAC (borax is not regulated) by the British Columbia Ministry of the Environment. A leaching study conducted by Forintek confirmed that, F-2 owing to the adhesion of DDAC to lumber, should under the most unfavourable conditions meet this performance requirement.

The Borax component of F-2 serves to potentiate the efficacy and, as well, through diffusion into the lumber provide a measure of protection against decay fungi. Equally, importantly, the Borax buffers F-2 solution to just slightly on the basic side and for this reason F-2 is very material friendly.

F-2 is readily diluted with water to form a solution in the range 2 to 5 percent DDAC for spray application. For dip application of rough sawn lumber, solutions of 1 to 2 percent DDAC are recommended. Foam control is imperative with F-2 and to this end Walker Brothers have designed excellent defoamer application equipment which when combined with T-2184, F-2 Defoamer provides trouble free application.

For applications where coloration is a requirement Walker Brothers recommends T-2186 Gold colorant a product which is fully compatible with F-2 Concentrate and which does not affect the efficacy of the treatment.

NP-1® SAPSTAIN CONTROL CHEMICAL

Alan S. Ross, Ph.D.
Vice-President
Technical Director

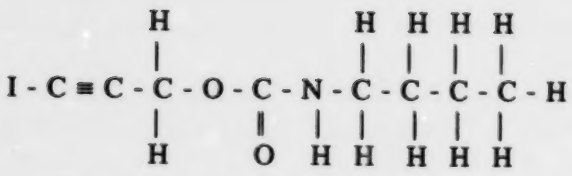
Kop-Coat, Inc.

NP-1® Sapstain Control Chemical

NP-1® Sapstain Control Chemical is currently the most widely used antisapstain product in North America. The purpose of this paper is to provide a brief overview of the properties of NP-1 and its experiences to date in British Columbia lumber mills.

Background

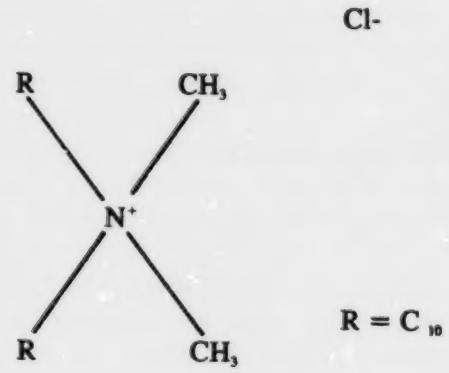
NP-1 was originally developed as a replacement for chlorinated phenates. Of over 400 compounds and combinations evaluated, a mixture of IPBC (Figure 1, a material commonly used as a mildewcide in paints) and DDAC (Figure 2, a widely used disinfectant) was found to have the optimum mix of properties regarding health, safety, environmental compatibility and efficacy.



3-iodo-2-propynyl butyl carbamate

IPBC

Figure 1



Didecyldimethyl ammonium chloride

DDAC

Figure 2

The DDAC/IPBC mixture was demonstrated to have a synergistic effect against fungi. This synergism was the basis of patents granted on the NP-1 technology in the U.S.,[1] Canada[2] and other countries.

A data package on the health and environmental effects of NP-1 and its active ingredients was submitted to the U.S. EPA, which granted a full U.S. registration in 1985.

On August 1, 1990, Agriculture Canada, in a CAPCO note,[3] announced that it had granted registration to NP-1 and several other DDAC or IPBC based antisapstain products because they were "considered essential for effective control of the full range of organisms that cause sapstain in various wood species."

U.S. Experience

NP-1 was introduced commercially in the U.S. in 1985. Since that time it has gained widespread acceptance. Currently NP-1 is used in about 550-600 of the approximately 700 major U.S. lumber mills that treat with antisapstain products. In addition, approximately 75-80% of the lumber exported from the Pacific Northwest is protected with NP-1.

NP-1 is typically applied by spray or dip systems. Species commonly treated in the U.S. include western and southern pines, Douglas fir, red oak, and hemlock.

Canadian Experience

Canadian evaluations of NP-1 started well before the registration was granted. In 1986 Tony Byrne of Forintek Canada conducted field tests on NP-1.[4,5] He found that after 12 months it was as effective as chlorinated phenates on hem-fir. Moreover, NP-1 fully controlled brown mold while the chlorophenate did not.

In 1988, production trials were run at two B.C. lumber mills. The product performed well with no worker safety problems. Lumber treated in the latter run was exported to Japan and Italy where it was inspected 6 and 12 months after treatment.

In both inspections the NP-1, utilized at recommended retention levels, was shown to protect the lumber from sapstain, mold and decay. Controls utilizing of another chemical did not provide adequate protection.

NP-1 was introduced commercially in British Columbia in August 1990. Acceptance to date by lumber companies, mill workers, union officials and regulatory authorities has been very favourable. At this point, approximately 50 percent of all British Columbia coastal export lumber is being treated with NP-1.

Performance

NP-1's performance in commercial use is well recognized. As noted previously, the DDAC/IPBC combination provides a unique, synergistic mix which has far greater activity against fungi than either ingredient by itself. This has been demonstrated repeatedly in both the laboratory and in field trials.[6]

The real workhorse of the NP-1 formula is the IPBC. It is efficacious against a wide variety of fungi and could be used alone, except that it would be prohibitively expensive. The DDAC alone is not effective for long-term protection.[1,2] However, in NP-1 it complements the IPBC--synergistically adding to the overall efficacy while at the same time acting as a surfactant and a bonding agent.

The ability of NP-1's active ingredients to readily bond to wood is well documented.[7,8] The DDAC, like many quates, has high substantivity to cellulose, making it resistant to water leachability. It fixes to wood by both absorption and cation exchange. Its leaching resistance has been reported in a number of papers including a publication by Nicholas et al. in the January 1991 issue of the Forest Products Research Journal.[9] In that work it was demonstrated that DDAC retention levels in treated pine blocks were unaffected by water leaching. Other work has shown IPBC to fix to wood as well. In the NP-1 formula it is believed that the DDAC forms a complex with the IPBC which enhances the stability and fixation to wood of both components.

NP-1 has demonstrated efficacy against a wide diversity of decay, mold and staining organisms on many wood species and under a broad range of climatic conditions.[6]

NP-1 Concentrate contains 72.4% active ingredients, which is the highest concentration of any commercial antisapstain product. This, and the synergistic activity of its two components, allows the product to be used at dilutions which are highly cost effective relative to other materials.

Worker and Health Safety

Toxicology data bases have been submitted to Health and Welfare on NP-1 and both of its active ingredients.[10] The data base on IPBC is essentially complete; that for DDAC is well in progress. DDAC has a long use history in Canada as a hospital disinfectant. The toxicity profile on NP-1 is quite favourable and it has been show in human patch testing not to be a skin sensitizer.[11]

No serious worker health problems have been encountered with NP-1 in its five years of wide commercial use in U.S. mills. In Canada, worker response to NP-1 start-ups has also been very favourable. Worker monitoring continues on an ongoing basis in British Columbia.

Environmental Profile

NP-1 has the advantage of rapidly biodegrading if it gets into the soil, streams, lakes, or oceans. The half-lives of both IPBC and DDAC in these environments has been measured to be a matter of hours.[12] As a consequence, NP-1 is nonpersistent in soil or groundwater. This is very critical since the persistence of many pesticides impacts stormwater runoff and groundwater contamination regulations. This is a far deeper issue than fish toxicity in the U.S. and it is believed that concerns about pesticide persistence will further impact Canadian regulations in the near future.

In testing carried out by the British Columbia environmental authorities, NP-1 has been shown to be fifty times less toxic to fish than historical chlorophenate-replacement products.[13]

On of the research needs in this area is for a reliable analytical test method capable of detecting NP-1 in the environment at below the part-per-million level. Several laboratories are currently attempting to develop such a test method; and an interim method based on IPBC analysis has recently been approved by the British Columbia Ministry of the Environment.

Handling Characteristics

NP-1 is a highly concentrated formula which is easily diluted with water under typical sawmill conditions. It is an extremely stable micro-emulsion with a storage life of at least five years. Working dilutions are noncombustible and stable to wide ranges of pH, water hardness, freeze-thaw, and contamination by sawdust, dirt and other materials typically encountered in sawmills.

NP-1 is compatible with many of the ancillary products used by sapstain treaters. Several colorants have been approved for use with NP-1. Borax and soda ash, which are sometimes used as extenders for NP-1, are quite compatible with it. For iron stain eradication, Kop-Coat has developed Iron Stain Control Additive ISCA-250® which is widely used in combination with NP-1.

Quality Assurance

A comprehensive quality assurance program is provided to all NP-1 users. This includes a field test kit to measure NP-1 solution strength, which is backed up by regular checks using a laboratory titration.

A special coverage indicator has been developed to be able to detect the presence of NP-1 on freshly treated lumber.

NP-1 retention is measured by a sophisticated method known as Neutron Activation Analysis.[14] This is done by a laboratory at the École Polythechnique in Montreal. Mill samples of treated wood are regularly submitted to the laboratory where the precise surface retention of NP-1 is analyzed in micrograms per square centimetre.

Kop-Coat Support

This product would not be successful in the U.S. or Canada without an intensive support effort provided by the manufacturer and this affiliates. This includes regular servicing from a Vancouver-based distributor. For mill start-ups Kop-Coat sends in a team of experts to assist mill personnel. This includes engineering, chemical and worker-safety specialists. They remain on site for several days to several weeks depending upon the complexity of the start-up. A comprehensive training program is presented to all mill workers who interfaced with the product.

This is followed up by regular support visits and the extensive Quality Assurance Program described earlier.

At the request of Agriculture Canada, Kop-Coat has written a Code of Good Practice[15] covering procedures for the safe use and handling of NP-1. This document is in printing and will be made available shortly to all users.

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NYTEK GD

C.H. Palmer, D.F. Myers, Ph.D., G.D. Rosebery, Ph.D.

Maag Agrochemicals Inc.
A Subsidiary of Ciba-Geigy Limited

MAAG was recently merged into CIBA-GEIGY, a company with sales of over $ 15 billion world-wide. CIBA-GEIGY is a Swiss based company with the largest fungicide research capabilities of all the chemical companies searching for anti-sapstain chemicals.

The active ingredient in NYTEK GD is copper-8-quinolinolate. The formulation is a flowable product, people-friendly and easy on sawmill equipment. NYTEK GD has a buffered pH of about 9. MAAG Agrochemicals Inc. is the Canadian registrant of copper-8-quinolinolate technical and holds the toxicology package required for registration. Chapman's PQ-8, a copper-8-quinolinolate formulation is also dependant on MAAG's technical registration. Recently MAAG advised Agriculture Canada that it would provide additional registration information for the re-evaluation of the compound.

In September 1990, a 15 ppb discharge limit in storm water run-off was placed on oxine copper. MAAG has taken the environmentally responsible position of monitoring the discharge of sawmills using NYTEK GD. In addition to monitoring, MAAG initiated a leaching study with Forintek Canada Corporation to determine the leaching potential of NYTEK formulations. The most important conclusion relevant to the discharge limit issue was that an electrostatically applied formulation in mineral oil showed a significant reduction in leaching potential (up to 90%) compared to a standard spray application of water-based NYTEK GD.

Electrostatic application offers significant advantages to NYTEK technology. These include: (1) Better targeting of wood and product performance through improved transfer efficiency and surface distribution. (2) Enhanced user-safety in the mill due to a closed system design and elimination of product recycling. (3) Less waste for disposal because the total volume of applied product is reduced. (4) Favourable cost/performance ratio. (5) Reduced leaching potential to curtail the hazard to fish. The commercialization program is designed to confirm these benefits and includes an evaluation of different formulations of NYTEK, formulation efficacy, additional leaching studies and application equipment. The objective is to provide a complete electrostatic spray system to the forest product industry by 1992. This NYTEK SYSTEM will meet current discharge limits and maintain the high-quality, broad spectrum sapstain protection and the people-friendly performance of the NYTEK trademark.

PQ-8

Mike Freeman
National Sales Manager

Chapman Chemical Company

Abstract

Copper 8-quinolinolate has an effective fungicidal activity against many organisms. When increased environmental pressure began to be placed on formulations containing either sodium pentachlorophenate or sodium tetrachlorophenate as a sapstain control chemical, copper 8-quinolinolate began to be evaluated. Many forms of copper 8-quinolinolate are available today as effective fungicides for shipping containers, fruit boxes, vegetables, stone fruit, and, of course, fresh-cut lumber. PQ-8, a proprietary formulation of Chapman Chemical Company, containing 5.4% copper 8-quinolinolate, is one of the most efficacious and cost-effective formulations for control of sapstain in Canada today. The following paper outlines modes of its toxicity and use of PQ-8 in Canada as an anti-sapstain chemical.

Key Words: Copper 8-quinolinolate, PQ-8, sapstain, anti-sapstain, wood preservation, oxine copper.

Background

Fresh-cut lumber in British Columbia, as well as other parts of the world, is highly susceptible to fungal attack and infestation. Although much attack of the fungal infestation on fresh-cut lumber does not cause decay, it can severely degrade the lumber in both appearance and value. Most commonly known as blue stain or sapstain, the fungi which typically attack wood in its fresh-cut state do not significantly cause any structural damage to the wood by degrading the cellulose structure. However, due to the food that is stored within the wood cells, particularly the parenchyma cells, these organisms may degrade the appearance of wood so that its market value may be one-tenth of the original value for unstained lumber. The importance of unstained lumber to the British Columbia market is so significant that sales of sapstain control chemicals into British Columbia are roughly one-third of the world market.

For many years, the water-soluble salts of pentachlorophenol, predominantly the sodium and potassium salts of either pentachlorophenol or tetrachlorophenol have been used to prevent sapstain or blue stain in fresh-cut lumber. Sodium pentachlorophenate, with its broad-spectrum control of many of the types of fungi, began to draw increased environmental pressures in the late 1970's and early 1980's. Cost-effective alternatives containing compounds such as copper 8-quinolinolate were developed and patented as alternatives to sodium pentachlorophenate.

Chapman Chemical Company, a leader in wood preservation since 1933, began to evaluate cost-effective and efficacious alternatives to pentachlorophenate salts over two decades ago. One of the products which resulted from their research work is a formulation registered around the world known as PQ-8.

Product Chemistry

PQ-8 is a true solution of 5.4% copper 8-quinolinolate solubilized by a patented method and sold in concentrate form in over 52 countries around the world. Copper 8-quinolinolate, commonly known as oxine copper, has limited solubility in many organic solvents and a typical water solubility of less than 14 parts per million. Chapman chemical developed a methodology to solubilize copper 8-quinolinolate in an alkyl aryl sulphonate with other cosolvents which allow cost-effective dilution and distribution of the active ingredient throughout the solution, which may then be used to uniformly coat exposed surfaces of fresh-cut lumber to prevent sapstain. Patents covering the use, composition and solubilization of copper 8-quinolinolate are Patent Nos. 4766113 and 4602011 (West and Nagel).

The use of an alkyl aryl sulphonate in its acidic form provides the most cost-effective method for solubilizing copper 8-quinolinolate known today. There are, however, drawbacks in using the acid form to solubilize copper 8-quinolinolate in that the resulting solution must either be buffered prior to being used in combination with ferrous metals to provide a neutral or alkaline solution, or spray equipment which will apply the product must be acid-resistant or stainless steel. Several studies have indicated that the use of copper 8-quinolinolate and the buffering agent, borax, adequately control many stain causing organisms.

Mode of Action

The use of copper for its fungitoxic effects has long been documented. Copper, when chelated with 8-hydroxy-quinoline, forms the molecule known as oxine copper, also known as copper 8-quinolinolate. In addition to the mechanism for copper being a fungitoxic compound, it should also be noted that 8-hydroxy-quinoline, one of the basic starting materials for copper 8-quinolinolate, also exhibits fungitoxic values.

Several mechanisms are thought to occur when using copper 8-quinolinolate as the fungicide to control sapstain in fresh-cut lumber. The copper itself will exhibit a fungitoxic value to the organisms, which will not allow sapstain to occur. In addition, the role of the 8-hydroxy-quinoline is thought to interfere with the essential metabolism of the decay fungi, chelating out essential metals necessary for the metabolism of the
fungi to occur.

Efficacy and Test Results

PQ-8, originally introduced into field trials in the early 1980's, has been tested by many laboratories, including Forintek Canada Eastern and Western Labs, Oregon State University, Mississippi State University, Michigan Tech, and many others. Results of the Forintek Canada lab (Western lab) study performed in 1985 and 1986 indicate that PQ-8 controlled sapstain and mold better than sodium tetrachlorophenate. Results of PQ-8 on SPF were better than sodium tetrachlorophenate, results on Hem-fir indicated that PQ-8 was better than sodium tetrachlorophenate, and PQ-8 provided one-year protection on all tests and controlled mold better than sodium tetrachlorophenate. Copies of this study are available from Chapman Chemical Company.

Additional work on copper 8-quinolinolate in the form of PQ-8 has also been performed by Oregon State University and Mississippi State University. Noted efficacy of PQ-8 has been documented in over 50 trials worldwide.

Application Methods

PQ-8 may be applied by flow-coat, ultra low volume sprayer, bulk dip tanks, or cross-the-chain dip vat. Depending upon methods of application, the target deposition rate for copper 8-quinolinolate in treated wood will be 7 to 9 $\mu g/cm^2$ of wood surface. The target deposition rate for PQ-8 is typically maintained in bulk dip vats using a dilution ratio of 120 gallons of water to each one gallon of PQ-8 concentrate or, if buffered with borax, 150 gallons of water to one gallon of PQ-8 and the solution also containing 20 pounds of borax.

Using ultra low volume application equipment, it is best to calibrate using the known specific nozzle size, a regulated through-put on both linear and cross-the-chain spray chambers, by processing the material through an ultra low volume pre-mix tank with dilution ratios of concentrate ranging from 18:1 to 25:1, depending on the output of the ultra low volume sprayer.

For flow-coat or cross-the-chain dip vats, typical dilution ratios for PQ-8 are a dilution of one gallon of concentrate to 70 gallons of water.

Quality Control

PQ-8 lends itself to many automated quality control methodologies and many test methods suitable for both inorganic materials as well as organic products. For subscribers in the British Columbia area to the ASQAP program through Forintek for anti-sapstain quality assurance program, treated wood coupons and wafers can be easily sampled at the mill site and run by automated test methods through Forintek, using HPLC technology and running the sample after cleavage to form 8-hydroxy-quinoline through semiautomated test methodologies using reverse phase chromatography.

Similar samples can also be ashed and run for elemental copper content to determine levels of PQ-8 which may be cross-verified using the two test methodologies. In addition to these quality control techniques, test kit solutions are available free of charge from Chapman Chemical or its authorized distributors to determine actual solution strengths of the test solution and also the PAN indicator, which can easily detect copper 8-quinolinolate in solution strengths of high enough concentration to give adequate sapstain control on the surfaces of fresh-cut lumber, boards, and timber. The PAN indicator, as well as test kits, are available to adequately control both solution strength and application rates on fresh-cut lumber. In addition, many outside inspection agencies (Timber Products, etc.) have the ability to detect levels of active ingredient both in treated wood and treated wood after extended storage and shipment to determine if levels on the surface are adequate to provide four months, six months, and one-year protection.

Stormwater Discharge/Leachate

Tests are currently underway at Chapman Chemical Company and Forintek Laboratories to determine the amount of copper 8-quinolinolate found in treated wood storage runoff as well as leachate collection ponds present on sawmill yards. Preliminary data indicate that copper 8-quinolinolate, when applied to wood in an acidic media such as PQ-8, shifts the pH upon contact with the wood to a more alkaline, insoluble form and thereby fixes and adheres to the wood surface.

Preliminary data from several mills using PQ-8 indicate that copper 8-quinolinolate can be found in stormwater runoff in the 3 to 6 parts per billion level under worst-case conditions. Several leachate tests are being performed at Forintek to verify this on both laboratory and small-scale tests to look at application methods and specific application techniques which may minimize or reduce leachate levels in stormwater runoff.

Cost Effectiveness

Data has recently been compiled at many Pacific Northwest sawmills, including those in British Columbia, indicating that typical treatment costs for PQ-8 treated wood are approximately 25% of the cost of other commercially available treatments. Data from one mill indicated that on a cost per thousand board feet, typical cost ranges from $1.70 to $2.00 per thousand board feet (Canadian dollar/MBF) were regular results obtained from the mill requiring a minimum of 12 months' protection with no stain. These prices compare very favourably with other commercially available treatments which contain quaternary ammonium chloride salts with price ranges in the $9 to $10 per thousand board feet range.

Summary and Conclusions

PQ-8, a patented, proprietary formulation of Chapman Chemical Company, is capable of giving adequate 12-month protection of fresh-cut lumber in the British Columbia area at a very cost-effective ratio. The active ingredient, copper 8-quinolinolate, found in PQ-8 at a 5.4% level, is of extremely low mammalian toxicity, currently registered under Ag Canada, Environment Canada, and Fisheries and Wildlife jurisdiction, and the product itself contains a fungicide which has a complete toxicity data base.

Use of copper 8-quinolinolate at commercial sawmills should represent no short-term or long-term hazards associated with the use of that product, if used in accordance with label directions at specified rate.

RODEWOD 200EC - A New Antisapstain Product

Katarina R. Stepec
Technical Manager, Antimicrobials

Diachem Industries Ltd.

Introduction

Today I would like to introduce you to Rodewod 200EC, a new antisapstain that has recently been approved by Agriculture Canada and thus is just entering the marketplace. However, I would first like to tell you about the companies associated with this product.

Janssen Pharmaceutica is a Belgian company whose research has resulted in the development of improved medicines to cure human disease as well as products which protect plant and animal health. Janssen has also developed azaconazole, the active ingredient in Rodewod 200EC, which is used worldwide for wood preservation.

Diachem Industries Ltd. formulates and distributes Rodewod 200EC in Canada. Diachem is a Canadian owned specialty chemical company which manufactures, sells and services products for the forest industry.

Characteristics of Rodewod 200EC

Some of the properties of Rodewod 200EC are presented in Table 1.

TABLE 1. CHARACTERISTICS OF RODEWOD 200EC

Active Ingredient	Azaconazole
Registration Number	21822
Appearance - Concentrate - Use solution	 Clear amber fluid pale off-white/yellow fluid
Odour - Concentrate - Use solution	 Mild antiseptic odour Minimal
Foaming Properties	Mild
Water Repellant Compatibility	Yes
Solution Test Method - Laboratory - Field	 Yes Under Investigation
Retention Test Method	Yes

It is important to note that azaconazole is the first wood protection active in many years which has submitted a complete data package to Agriculture Canada and has been granted a full registration.

Acute Toxicity

Table 2 outlines some of the acute toxicity data which has been generated for Rodewod 200EC and its active ingredient.

TABLE 2. ACUTE TOXICITY

	AZACONAZOLE	RODEWOD 200EC
LD 50 Rat, oral	308 mg/kg	1291 mg/kg
LD 50 Rabbit, Dermal	>3100 mg/kg	>2190 mg/kg
Dermal Irritation Rabbit	Slight	Slight
Eye Irritation Rabbit	Negative	Positive
Dermal Sensitization	Negative	Negative
LC 50 Inhalation	--	1.48 mg/L

Azaconazole is classified as moderately toxic to rats by ingestion while the formulation is considered to be only slightly toxic by the same route of entry. As with any chemical, good industrial hygiene practice is recommended to avoid the accidental ingestion of minute amounts of azaconazole and thus workers should wash their hands thoroughly before eating or smoking.

Based on the results of an acute dermal study and a dermal irritation test, both Rodewod 200EC and azaconazole were found to produce a slight irritation upon contact with skin. Consequently it is recommended that workers handling the product in its concentrated or diluted form, or handling freshly treated lumber, wear protective gloves and clothing. Studies confirm that neither azaconazole nor Rodewod 200EC are dermal sensitizers.

While azaconazole itself is not an eye irritant, Rodewod 200EC will cause eye irritation if contact is made. Consequently, it is essential that chemical goggles or safety glasses be worn when handling this product.

Note that an inhalation LC50 for azaconazole has not been given in Table 2. This stems from the fact that a study evaluating the maximum attainable concentration of azaconazole

did not result in any detrimental effect to the test rats.

A four hour inhalation study produced an LC50 of 1.48 mg/L for Rodewod 200EC. While this value is relatively high, the product should still be stored in a well ventilated area. Sprayboxes must be properly maintained to ensure that workers are not exposed to aerosol mists. Owing to the fact that the product is not volatile, there is no inhalation hazard associated with handling treated lumber.

A detailed list of safety precautions and protective equipment required when handling Rodewod 200EC solutions, as well as a description of first aid procedures to be implemented should contact with Rodewod 200EC solutions occur, can be found in the Code of Good Practice for this product.

Aquatic Toxicity

Some of the aquatic toxicity data that has been generated for azaconazole is presented in Table 3.

TABLE 3. AQUATIC TOXICITY OF AZACONAZOLE

SPECIES	96 HOUR LC50
Rainbow Trout	21.1 PPM
Brown Trout	22.0 PPM
Zebra Fish	36.9 PPM
Chinook Salmon	26.9 PPM

With the exception of Ecobrite, azaconazole is significantly less toxic than the other antisapstains currently on the market.

The Ministry of the Environment has not established effluent discharge limits for azaconazole as yet, but based on the acute and aquatic toxicity data, one may estimate that a discharge limit of approximately 20,000 ppb will be implemented.

Efficacy

As mentioned earlier, azaconazole is used worldwide for wood preservation and sapstain control. Some of the countries currently using azaconazole are Belgium, France, Portugal, Australia, and The Netherlands.

Although shipping trials have not been conducted, successful lab tests and field trials show that Rodewod 200EC is effective in controlling the growth of mold and sapstain fungi.

Table 4 outlines the results obtained in a study conducted at Oregon State University whereby pieces of pine, hem-fir, and Douglas fir were dipped in various concentrations of Rodewod 200EC and then challenged with a suspension containing the spores and mycelium of various mold and sapstain fungi. The samples were incubated for 6 weeks and then graded on a score of 0-10, whereby 0 means no stain and 10 means severely stained. On this scale a rating of less than 1 is considered acceptable. As can be seen, pine treated with a 75-1 dilution protected the wood from mold and stain while a 50-1 dilution was required to provide good protection to hem-fir and Douglas fir.

TABLE 4. OREGON STATE UNIVERSITY STUDY
ACCELERATED EXPOSURE THROUGH INOCULATION

	DEGREE OF STAIN		
RODEWOD 200 EC DILUTION	PINE	HEM-FIR	DOUGLAS FIR
Control	5.1	6.4	8.0
400-1	3.1	5.7	5.4
200-1	2.6	6.6	5.7
150-1	1.6	3.4	3.6
100-1	1.7	2.9	1.6
75-1	0.4	3.1	1.9
50-1	0.3	0.3	0.9

A similar study was conducted in New Zealand. In this test, no fungal growth was present on pine boards treated with a 25-1 dilution and only a trace amount of mold was detected on one of the boards treated with a 50-1 dilution. When a 100-1 dilution was applied, 9 out of 10 boards were free from fungal growth while 10% of the tenth board was infected with mold.

Forintek has also evaluated the efficacy of Rodewod 200EC. In their study, green hem-fir and SPF were treated with several concentrations of Rodewod 200EC and then inoculated with mold and sapstain fungi. The boards were graded after a four month storage period.

The results of this study are outlined in Tables 5 and 6. In Table 5, the data is presented in terms of acceptability of the treated boards. The performance of a treatment was rated as satisfactory if 90% of the test pieces were acceptable.

TABLE 5. FORINTEK FIELD TRIAL - FOUR MONTH RESULTS

SPECIES	% ACCEPTABLE					
	RODEWOD 200EC			NaPCP		
	0.2% a.i	0.4% a.i.	0.8% a.i.	0.5% a.i.	1% a.i.	2% a.i.
Hem-fir	69	78	94	66	93	99
SPF	31	64	68	15	33	85

This data shows that application of a Rodewod 200EC solution containing 0.8% azaconazole to hem-fir provides good protection. A solution containing 1% active should impart better protection to hem-fir over a longer storage period. SPF should be treated with a solution containing >0.8% azaconazole (ie. 1.0-1.2% active) to obtain good protection.

Table 6 outlines the results based on rating scores of 0-5 whereby:

0 = no growth
1 = trace of fresh fungal growth
2 = little fresh fungal growth
3 = moderate fungal growth
4 = heavy fungal growth
5 = very heavy fungal growth

In this study, a score of 1 or 2 for fungal growth is not sufficient to cause significant devaluation of the common grades of lumber.

TABLE 6. FORINTEK FIELD TRIAL - FOUR MONTH RESULTS

Species/Fungus	AVERAGE SCORE					
	RODEWOD 200EC			NaPCP		
	0.2% a.i	0.4% a.i.	0.8% a.i.	0.5% a.i.	1% a.i.	2% a.i.
hem-fir - mold	0.1	0.2	0.5	1.6	0.7	0.4
- stain	1.5	1.2	0.5	0.6	0.0	0.0
- decay	0.0	0.0	0.0	0.1	0.0	0.0
- overall	1.5	1.3	0.9	1.9	0.7	0.4
SPF - mold	1.8	1.0	1.0	2.7	2.7	1.4
- stain	2.9	1.6	1.4	1.8	1.1	0.5
- decay	0.3	0.0	0.1	0.0	0.0	0.0
- overall	3.5	2.0	2.1	3.6	3.3	1.6

This data illustrates that Rodewod 200EC is more effective against mold than staining fungi at the concentrations tested.

In Tables 5 and 6, the data obtained for Rodewod 200EC is compared to that generated for sodium pentachlorophenate in the same test. Rodewod 200EC solutions containing 0.8% azaconazole and 1% active NaPCP provide equal protection to hem-fir while Rodewod 200EC out-performs NaPCP on SPF at the same concentrations. It is anticipated that a 1.0% active Rodewod 200EC dilution will provide the same protection to hem-fir and SPF as a 2% NaPCP solution.

Summary

Rodewod 200EC is a new antisapstain that is, with the exception of Ecobrite, less harmful to human and aquatic life than all of the products currently being used for lumber protection. Azaconazole, the active ingredient in Rodewod 200EC, is used worldwide as a wood preservative and sapstain control product. Laboratory tests and field trials confirm that Rodewod 200EC will effectively control the growth of mold and stain fungi on lumber.

TIMBERCOTE II - Product Properties And Benefits

Elliot Martin / Paul Stovicek

Napier International Technologies, Inc.

The Product - Its Purpose and Objectives

Timbercote is the most technically advanced anti-sapstain product on the market today. It was designed to be a "New Generation" product with superior performance in all critical areas. The objective in developing Timbercote was to achieve outstanding performance in the areas of health, safety, environmental compatibility, efficacy and cost. The goals of Timbercote are to provide a product that is extremely safe, effective and cost competitive.

The design of the product was to determine and incorporate into a compound, the safest and most effective fungicide available so as to ensure that it would stay on the lumber and not wash off. As a result, DDAC a proven safe fungicide, is combined under a patented process with an inert latex, a proven effective bonding agent, to create a product with superior efficacy. The other objective was to create a product that would penetrate the wood substrate and offer "internal" as well as surface protection. Timbercote is the only recently registered product that offers this combined protection.

Overall Performance

DDAC used in recommended quantities has a proven record as an effective fungicide against the wide range of fungi encountered in the lumber industry. DDAC, like many quaternary compounds, has a high substantivity to cellulose and a natural affinity to adhere to wood by cationic exchange. However, the natural ability of DDAC to adhere can be significantly lessened when exposed to, the acidic conditions encountered in acid rain, and the varying acidic levels found in the lumber itself. Also, the natural fixation of DDAC does not occur immediately. Depending on weather and wood conditions it can take up to two weeks to adhere completely to the saturation point. For these reasons Timbercote does not depend, for complete protection, on the natural ability of DDAC to adhere to wood. Timbercote combines DDAC with latex, a proven strong and effective bonding agent. At the recommended application levels of 100 $\mu g/cm^2$ Timbercote provides, due to the latex component and its strong bonding abilities, substantial retention in all weather conditions.

Latex - Its Sealant Ability

The process by which latex is incorporated into Timbercote is a patented process. This process microencapsulates a portion of the quaternary ammonium (DDAC) in the latex, leaving the balance of the DDAC in active solution to cover and penetrate the wood. Due

to the ability of latex to polymerize quickly, and its inability to penetrate the wood, a micro thin latex film is formed on the surface of the wood structure, much like a plastic cello wrap, sealing the DDAC solution between the latex film and the wood. This process provides a form of double protection, through the combination of the natural ability of DDAC to adhere to the wood and the sealant properties of the latex.

Immediate and long term protection is mandatory for effective sapstain control. The latex in Timbercote provides superior performance. It grants a number of benefits to the user. The latex seals in the active ingredient and protects against precipitation wash off. Because latex is a strong effective bonding agent it reduces leaching to extremely low levels. It also polymerizes quickly to produce a virtual immediate sealant versus a protracted protection via the natural adhesion of DDAC. Lastly, because the amount of latex in the solution can be adjusted, leaching can be decreased by increasing the amount of latex which also improves the efficacy. The latex component truly separates Timbercote from all other anti-sapstain products. There are a number of safe fungicides on the market today, the problem to overcome is to prevent their excessive leaching which reduces their effectiveness. Timbercote eliminates this concern.

pH Level - The Ability to Penetrate

To attain superior performance an anti-sapstain must have the ability to penetrate the wood. Without penetration you achieve surface protection only, with no internal wood protection against stain, decay and mycelium. In order to penetrate inside the wood a compound must have a pH factor lower than 7. Timbercote when applied has a pH ranging from 5.5 to 6.5. This low pH factor allows a portion of the DDAC to penetrate the wood substrate providing the user with internal as well as surface protection. The lower pH also allows for increased mobility of the DDAC increasing the migration and penetration properties of the product. Also, because a portion of the DDAC penetrates the wood, leaching is once again reduced.

Health, Safety and Environmental Compatibility

Another major benefit is that Timbercote was designed for safety. Timbercote has no organic solvents, hydrocarbons or other additives. Timbercote is an unclustered product having only one active ingredient. Therefore, there is no concern for potential interactions between multiple active ingredients causing hazardous side effects. DDAC has a long and proven record of use in hospital disinfectants and health and beauty aids. The other component in Timbercote is an inert latex. Latex which is an inactive ingredient has a long and safe record. Therefore, the toxicity profile on Timbercote is extremely favourable with an LC_{50} of 12.4 ppm. This equates to Timbercote being approximately 250 times less toxic than chlorophenols and 5 to 15 times less toxic than other currently registered anti-sapstain products. As a result no serious worker problems have been encountered.

Timbercote is biodegradable in the soil, rivers and oceans. The half life of DDAC is very short and DDAC does not accumulate in the soil or ground water. DDAC has an allowable storm sewer leachate of 700 ppb. Timbercote has been measured under various tests to show only 45 to 60 ppb, well under current legislation. Because Timbercote has only one active ingredient, DDAC, which does not contain an organic halogen, there is no possibility of interactions between clustered active ingredients and wood substrates to produce carcinogenic halogenated phenolics.

Quality Control and Service

Quality control assurance, and service are as important as the product itself. Wood protection can only be assured if the required coverage and retention is attained on the wood. To this end Timbercote provides all services at no additional cost. Napier International visits all accounts every week to ensure the required coverage. Testing of water pH, dilution ratios, penetration, coverage and retention levels are tested, as per mill requirements, on a weekly basis. This process manages your protection level (to make sure you have the required coverage) and your cost of coverage (to make sure you are not over applying and increasing your costs needlessly). All defoamers, anti-ironstain and colouring if desired or necessary, are included at no additional cost. This level of service is unmatched in the industry today.

4. PESTICIDE REGISTRATION SYSTEM FOR ANTI-SAPSTAIN PRODUCTS

Michelle Edwards
Regional Pesticide Officer

Agriculture Canada

Agriculture Canada administers the Pest Control Products Act and Regulations which requires control products, including anti-sapstain products, to be registered. Registration is a presale assessment to ensure the product is both safe and effective.

The current federal registration process has been under scrutiny by an Independent Pesticides Review Team with the involvement of many interest groups including environmentalists, unions, consumer groups and representatives from the pesticide industry. Many recommendations have been made to the Minister of Agriculture and they will be implemented at his discretion.

Currently, the pesticide companies produce data regarding a product's safety and efficacy and forward this to Agriculture Canada. Health and Welfare Canada reviews the environmental information, and Fisheries and Oceans reviews the affect of the products on fish. Based on the advise from these agencies, Agriculture Canada makes its regulatory decisions.

There are two types of regulatory approaches commonly used in Canada and internationally. A complete package of scientific studies supporting a product generally allows an acceptable course of action. When there is a less than ideal science data base and difficult decisions must be made, agencies world-wide make use of a regulatory management technique. This approach entails scientific and public policy components, and utilizes consultation and communication in an effort to reach a balanced decision.

Based on this approach, Agriculture Canada was advised by the multi-stakeholder forum regarding regulatory decisions on anti-sapstain products. In response, Agriculture Canada made the following actions. Registration of all sapstain control uses of tetrachlorophenol and pentachlorophenol in Canada was terminated, as requested by manufacturers, on December 31, 1990. Temporary registrations, subject to annual review, for the products NP-1, F2 and Timbercote were issued based on the action ingredients DDAC and IPBC. A formal re-evaluation of antisapstain products containing TCMTB, copper-8 and borax will be announced. For more details on this process, do not hesitate to contact Agriculture Canada.

5. Review of New Products in the Registration Process

Moderator: Hugh Martin, MacMillan Bloedel Ltd.

AP-143

Kevin Archer
Research Manager

CSI (Chemical Specialties, Inc.)

AP-143 is an anti-sapstain micro-emulsion developed by North Carolina based Chemical Specialties Inc. (CSI), a subsidiary of Laporte plc.

The formulation can be applied using dip or spray techniques to a variety of wood species. Field trials to date have demonstrated its efficacy in a range of climatic conditions at several geographic locations. The product is fully water miscible and exhibits exceptional freeze/thaw stability. High temperature stability is currently under evaluation. AP-143 is a clear amber liquid with a mild sweet odour. Corrosion testing to date has demonstrated that the product does not attack metal containers or metal components found in anti-sapstain spray or dip systems.

The active ingredients are Azaconazole and 3-iodo-2-propynyl butyl carbamate (IPBC) in a 1:1 ratio. The concentrate contains 5% active ingredient by weight.

A comprehensive toxicity profile has been developed for the product. The results have shown that AP-143 can be classed as a mild to moderate mammalian toxicant. Both oral toxicity and acute inhalation toxicity are moderate, the propensity for skin irritation is low but AP-143 will irritate unprotected eyes. The LC_{50} (96h) for Rainbow trout was determined to be between 5.6 and 10 mgl^{-1} which demonstrates that the toxicity of AP-143 to fish is relatively low.

The anti-sapstain efficacy of AP-143 has been tested extensively by CSI on southern yellow pine and on other species by two independent research organisations. A four month trial was conducted by Tony Byrne of Forintek on Douglas fir, spruce-pine-fir and hem-fir. Results are presented in Figures 1, 2 and 3. The data show that AP-143 performs well on three species groups. The performance of AP- 143 on hem-fir at 2% a.i. concentration is similar to that of Busan 1030 at the same concentration (Figure 1). With the other two species groups, AP-143 performs better than Busan 1030 (Figures 2 and 3).

An anti-sapstain dip trial with AP-143 was conducted by the New Zealand Forest Research Institute using radiata pine sapwood. Over the duration of the trial (24 weeks), AP-143 at a concentration of 0.2% a.i., outperformed NP-1 at 1.0% a.i. and Busan 30 at 0.4% a..i. Both chemicals are currently used at these concentration levels by the New Zealand sawmill industry for dip treatments (Figure 4). The data from these trials clearly demonstrates that AP-143 is effective on a range of timber species exposed in different climatic regions.

One other feature of AP-143 noted by several investigators is the fact that the surface of treated timber appears very bright and clean.

AP-143 is currently being evaluated by the Queensland Department of Forestry in Australia. A production mill trial is planned for Canada in the spring of 1991 and in New Zealand for late summer/autumn. A registration package was submitted to Agriculture Canada in December 1990. United States EPA registration is in preparation.

Quality control procedures are available to determine the concentration of AP-143 both in solution and after wood has been treated.

In summary, CSI believes that the combination of low mammalian toxicity, low fish toxicity and superior performance make AP-143 a valuable alternative to existing chemical formulations for effective control of sapstain organisms on a wide range of timber species.

Forintek field trial

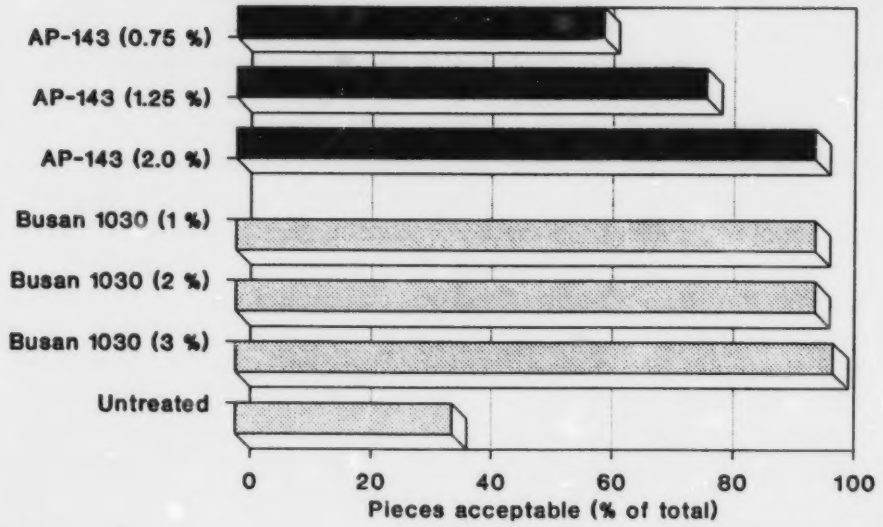

Figure 1

Hem-fir (4 months exposure)

Forintek field trial

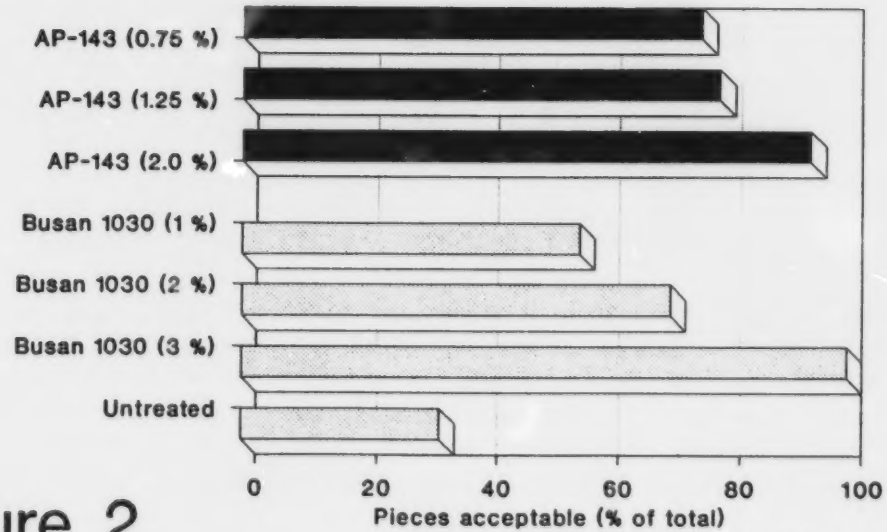

Figure 2

Douglas fir (4 months exposure)

Forintek field trial

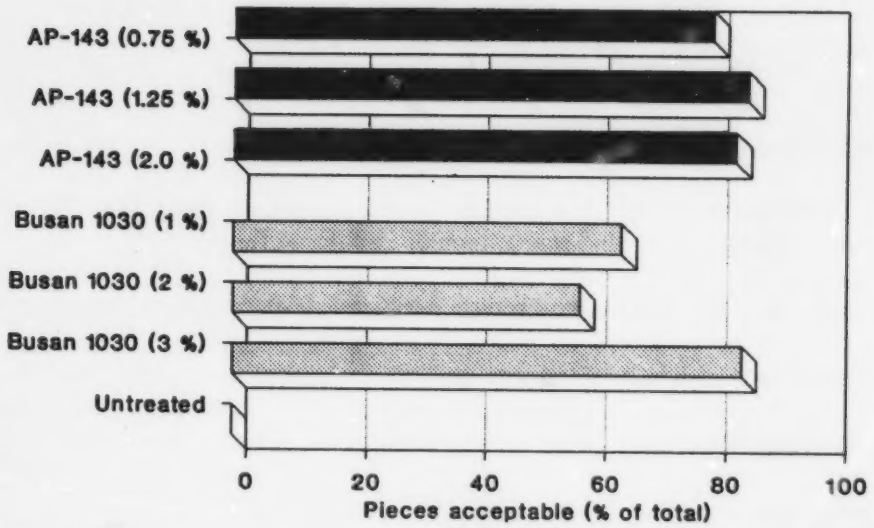

Figure 3

S-P-F (4 months exposure)

NZ field trial

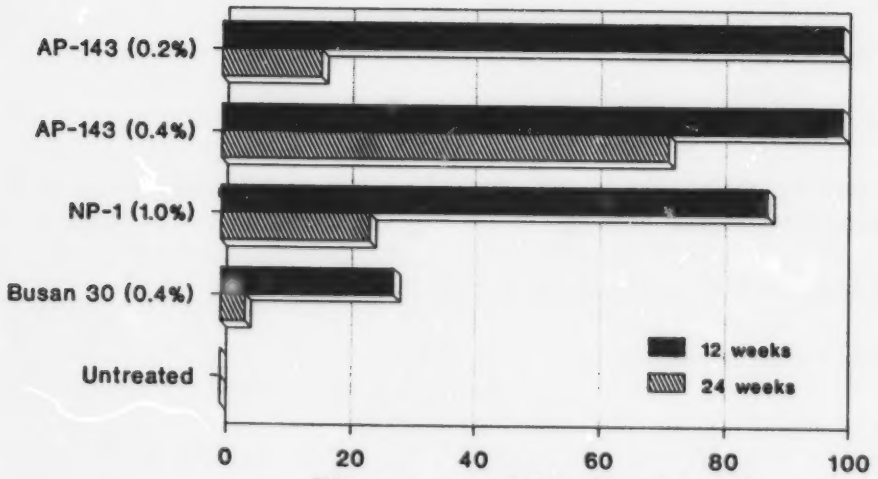

Figure 4

FRI trial (6-8/90) using *P. radiata*

DEFENCE ANTI-STAIN

Kurt Engelhardt
Marketing Manager

Hoechst Canada, Inc.

Temporary Protection Of Sawn Wood Against Fungi

General: Defence Anti-Stain is a product for the temporary protection of freshly sawn wood against sapstain (e.g. blue-stain), moulds and decay fungi.

Defence Anti-Stain is a liquid concentration product, non-flammable and moderately toxic.

Presentation: white suspension, concentrate (SC)

Colour on wood: colourless

Main application: temporary protection of sawn wood

Composition: based on fungicides

Efficacy: preventative action against wood discolouring (e.g. blue-stain) and surface fungi (moulds)

Density: 1.142 g/cm^3 at 20° C

Flash point: not applicable

Odour of product and solution: odourless

Product stability: the product is stable for at least two years, provided that the product is well stored in the original packing.

Cold stability: till 5° C (preferably keep from freezing)

Before use: agitate before use

Methods of application: dipping, spraying, brushing

Dosage: = 0.50-0.75% of Defence Anti-Stain (0.50-0.75 litre of Defence Anti-Stain in 100 litres of water) for ca. 1-2 months protection of sawn wood.

= 0.75-1.00% of Defence Anti-Stain (0.75-1.00 litres of Defence Anti-Stain in 100 litres of water) for a longer protection of sawn wood.

Uptake: = 100 ml dilution per m^3 wood surface, that means for boards with a dimension of 4 cm the minimal uptake is 5.5 litres of diluted product and for boards with a dimension of 8 cm the minimal uptake is 3.5 litres of diluted product per m^3 of wood.

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Treatment of sawn wood

The treatment has to take place immediately after sawing of the logs. The wood to be tested has to be moistened on all sides (100% covering). The treatment has to be done by means of dipping, spraying or brushing. The dipping time for board by board (piece by piece) treatment must be maximal 1-3 seconds. A longer period is not necessary. However, when the boards are closed stacked (use of sticks is recommended) longer dipping time is needed to reach a full covering inside. For good air drying of the wood after treatment, we strongly advise:

- Drain the boards for a certain period
- Protect the treated boards from rain
- Use sticks e.g. at every 8-10 boards

N.B. After a period of not-using the dipping bath the dipping liquid must be stirred first before using again.

Precautions

- Keep out of reach of children.
- Do not eat, drink or smoke during treatment.
- Keep away from food drink and animal feeding stuffs.
- Avoid contact with skin and eyes, and avoid inhalation.
- Wear rubber gloves during treatment and if necessary wear other protective clothes.
- Respect the regulations concerning the protection of the environment.

First Aid

No specific antidote available. Treat symptomatically.

Oral: In case of indigestion give the patient 1-2 glasses of water and carry out a rinsing of the stomach with potassium-per manganate (20 mg/100 ml). After that give the patient a

purgative like 30 g sodium sulphate in 250 ml water.

Skin and eyes: Wash skin with household soap. Wash eyes thoroughly with running water during 10-15 minutes. Keep the eyes open and turn the eyeball in all directions during washing. Seek medical assistance if irritation continues.

The Netherlands, June 1990.

PROPERTIES OF THE UNDILUTED PRODUCT:

- Composition : azaconazole 200 g/l
  carbendazim 130 g/l
- Density : 1.142 g/cm³ (at 20° C.)
- Flash point : not applicable
- Stability : for at least two years stable, when the product is well stored in the original packing.
- Corrosivity : not corrosive for metal, concrete, etc.
- Toxicity : according to OECD guide lines:
  - acute oral LD_{50} :851mg/kg (rat)
  - acute dermal LD_{50} : >4000mg/kg (rat)
  - skin irritation : slight (rabbit)
  - eye irritation : almost no effect (rabbit)

PROPERTIES OF THE DILUTED PRODUCT:

- Colour : cream-white
- Odour : odourless
- Evaporation/migration : negligible
- Acute oral/
  dermal toxicity : >4000 mg/kg (rat)
- Skin/eye irritation : not irritating

TYPE OF FORMULATION:

The type of formulation is: suspension concentrate (SC)

Advantages:

- Absence of emulsions and solvents:
  - colourless on wood
  - odourless
  - less pollution
  - less irritating
  - less chemical influences (more stable)
  - non-corrosive

- Higher concentration of active ingredient at wood surface, due to particles instead of real solution

- Less penetration, so more efficient use of the active ingredient

Conclusion : a safe and economic formulation

THE IDEAL ANTI-SAPSTAIN CHEMICAL IS REQUIRED TO BE (IRG/WP/3416):

	Defence Anti-Stain
° of high fungicidal activity, i.e. to sapstain, mould and decay fungi	++
° harmless to other plant life	++
° less-toxic to animals	++
° a less-irritant on skin contact	++
° colourless on wood	++
° odourless	++
° easy to apply	++
° non-corrosive	++
° chemically stable	++
° long-lasting on timber but not persistent in the environment	++
° available in commercial quantities	++

Conclusion : Defence Anti-Stain is from biological, toxicological and environmental point of view a promising alternative for Na-PCP.

PASSPORT

D.B. Smith
Supervisor, Ontario Technical Centre

ICI Chipman

PASSPORT contains the active ingredient hexaconazole (ICIA0523) which was discovered by ICI Agrochemicals in the early 1980's. Hexaconazole is a broad spectrum triazole fungicide effective against basidiomycete and ascomycete fungi. The mode of action is by inhibition of ergosterol biosynthesis.

Hexaconazole has been extensively evaluated for control of fungi on agricultural crops and is presently sold in 18 countries under the trade name ANVIL. ANVIL is expected to be sold in over 50 countries for use on 15 major agricultural crops by the mid-1990's.

Hexaconazole has been thoroughly tested for its toxicity to man and non-target organisms and for its effects and fate in the environment. These tests have demonstrated that hexaconazole is of low to moderate toxicity by oral, dermal and inhalation and is not a skin irritant. Hexaconazole is of low toxicity to fish and birds and is of low mobility in soil.

PASSPORT has been evaluated since 1986 for the control of fungi on lumber. A range of rates have been evaluated by dipping, conventional spraying and Electrodyn spraying in a total of 30 separate tests to date.

The Electrodyn technology is an ICI discovery which has been used in tropical agriculture for a number of years. The Electrodyn sprayer operates by electrically charging spray droplets which are then attracted to the lumber which has the opposite charge. Some of the advantages of this system include; greatly reduced operator exposure, improved coverage of all treated surfaces, improved retention on the wood, no recycling of spray due to high efficiency, greatly reduced contaminated waste and an oil based formulation with no dilution required.

A large number of experiments were conducted in Canada during 1990 with PASSPORT the majority being conducted in British Columbia.

In vitro assessment of hexaconazole demonstrated that it was very active against all species tested except Penicillium sp., a wood staining fungus. In the same experiment, thiabendazole was most active against Penicillium sp. and decay fungi and least active against mould fungi. This experiment clearly demonstrated a complimentary spectrum of activity for hexaconazole and thiabendazole against wood stain, mould and decay fungi.

PASSPORT applied with conventional spray equipment was superior to TCMTB and NP-1

against decay fungi however was less effective than TCMTB in controlling sapstain. PASSPORT + TBZ was consistently more effective than PASSPORT alone in controlling sapstain on all wood species and performed equal or superior to TCMTB in all tests. Stain was more important than decay on Hem-fir and Douglas fir lumber and decay more important than stain on S-P-F lumber.

In Electrodyn trials, PASSPORT applied at rates of 20 μg per square cm and higher provided control of stain, mould and decay fungi which was equal or superior to the standard TCMTB treatment on all major wood groups in both 4 month and 1 year storage tests.

PASSPORT and the Electrodyn sprayer will provide the lumber industry with the latest in technology and will be valuable tools for lumber protection in the 90's and beyond.

PREVENTOL O EXTRA

Pat Lepper
Technical Sales Representative

Bayer Canada, Inc.

Introduction

A special formulation of OPP was developed and adapted to the temporary protection of freshly cut and sawn timber against stain and mould fungi - Preventol OF.

Preventol OF

In testing, Preventol OF was found to be a "high quality, environmentally friendly, low-toxicity alternative to PCP/PCP-Na formulations". Its spectrum of activity is as broad as that of OPP, covering bacteria, yeasts, wood-destroying fungi and wood-discolouring blue staining and mould fungi.

Registration Status

Preventol O Extra has been submitted for registration in Canada in the material and wood preservation and hard surface disinfection categories.

Studies in all categories of toxicology as well as environmental chemistry and toxicology have been submitted. We have great hopes that our existing package of studies will show our product to be both effective and environmentally acceptable, and lead to a full registration.

Toxicity Data

Various toxicological studies, carried out with Preventol O Extra, ON Extra and OF have shown that these products have low acute toxicity, tables 3-4.

Ecotoxicity Data

Tables 8 and 9 show aquatic organism toxicity and biodegradability. A chinook salmon study (LC_{50} - 96 hour) will be completed by the summer of 1991.

Practical Testing

The paper, "2-Phenylphenol for the Temporary Protection of Sawn Timber Against Mould Infestation" written by Drs. Exner and Paulus outlines the results of field tests carried out around the world. Tests were run in Chile, Brazil, Switzerland, Canada, the Soviet Union

and Austria. In summary, Preventol OF was found to be effective against mould and blue-staining fungi when used on *Pinus radiata, Pinus elliottii, Pinus silvestris,* hem-fir and Soviet spruce and pine.

Concentrations of 4-6% OF were found to be effective when used against references of PCP-Na, with and without borax, and TCP-Na. Two mould fungi where OF was found to be ineffective were, most likely, *Phanerochaete sanguinea* and *Cephaloascus fragrans*, found in tests run in, respectively Switzerland and Canada. In Switzerland, the reference fungicide, 2.5% PCP-Na, as well as 6 and 9% OF solutions were all equally ineffective against *Phanerochaete sanguinea*, causing a reddish brown surface discolouration.

In Canada, neither a 4% Na-TCP nor a 24% Preventol OF (7.2% OPP) solution gave satisfactory results, after 4 months, against *Cephaloascus fragrans*, brown mould.

Present Uses

Preventol O Extra and its formulations are used in sawmills in Austria and the Alps, Sweden, Indonesia and the Pacific Northwestern USA, in various concentrations.

Summary - Preventol OF

- has low toxicity
- does not cause sensitization
- biodegrades quickly and well
- has thoroughly tested toxicological and ecotoxicological properties which have been thoroughly investigated.
- has a broad spectrum of microbicidal activity which has been proved in use.
- has good environmental compatibility.
- is a liquid concentrate which produces a true solution and not a dispersion or suspension.
- is odourless
- contains no solvents
- is non-flammable
- is non-volatile
- is easily miscible in water
- does not foam
- is easy to meter
- is insensitive to frost to -11° C
- does not corrode steel
- is compatible with PU Coatings
- allows the active ingredient to be absorbed evenly and constantly from the solution, causing no drop in the a.i. concentration
- allows the a.i. to be easily and reliably determined on-site using a portable photometer.

- allows the a.i. to be "fixed" to the wood as the acid surface of the wood absorbs the OPP alkaline salt and converts into OPP, which is practically insoluble in water.
- is free from dioxins and no dioxins are formed when OF is incinerated.

PREVENTOL A8

Introduction

In order to combat the main cause of economic damage to timber and millwork world-wide, mainly Basidiomycetes (brown and white rot), tebuconazole was chosen for its broad spectrum of activity.

Preventol A8

Table #10 shows the MICs for various mould fungi micro-organisms. Its effectiveness against wood-destroying fungi have made Preventol A8 a welcome addition to our wood preservation line.

Registration Status

Preventol A8 has been submitted for registration in Canada under the name Folicur for agricultural applications. Both the technical manufacturer's concentrate and an end use formulation have been submitted. Full feedback from key Federal advisors is not expected for 18 months.

Our plan is to amend the A8 registration, when issued, to include antisapstain application.

Toxicity and Ecotoxicity Data

Tables 11 and 12 provide a summary of the most important data. The Federal Health Office (FHO) has stated that this new fungicide does not constitute a health hazard when used in wood preservatives and has issued the RAL quality mark for wood preservatives (RAL-GZ830).

Practical Testing

To date, little practical testing has been conducted on a world-wide basis. A soil block test (EN113) has just been completed in the UK while another is pending in the USA.

Present Uses

Preventol A8 is not yet in use as a wood preservative.

Summary

In Summary, Preventol A8:

- is un-leachable
- is light-stable
- is heat-stable
- is non-volatile
- is useable in both solvent-borne and water-borne formulations
- can be analytically detected from treated wood and wood preservatives by gas chromatography and HPLC analysis.
- is compatible with other wood preservative constituents to extend our spectrum of activity.

Acute studies	
LD_{50} oral, rat	2,700-3,000 mg/kg
inhalation risk test with rats	dynamic vaporization (7h exposure) no mortality, no symptoms
Skin (rabbit)	slightly irritant (0.5h exposure) irritant (4h exposure)
Eye (rabbit)	slightly irritant
Sensitization	5% OPP in sesame seed oil 200 test subjects, dermal application: no skin irritation no sensitization Guinea pig maximization test (Magnusson-Kligman): only very slight sensitization potential

Table 3: Toxicity of Preventol O extra, the active ingredient in Preventol OF

Subacute studies	
32 days, oral rat	NOEL*200 mg/kg/day
4 weeks, dermal, mouse	the substance has no effect on body size and life expectancy only local dose-related ulcerous damage
Subchronic studies	
90 days, oral rat	NOEL 500 mg/kg/day
90 days, feeding test, rat	NOEL 1% OPP in food
6 months, oral, rat	NOEL 500 mg/kg/day
Chronic studies	
1 year, feeding test, dog	NOEL 500 mg/kg/day
2 years, feeding test, rat	NOEL 0.2% OPP in food

NOEL = no effect level

Table 4: Toxicity of Preventol O extra, the active ingredient in Preventol OF

Toxicity to aquatic organisms	
Leuciscus idus (golden orfe)	LC_0 20 mg/l, 96h exposure
Pimephales promelas (fathead minnow)	LC_{50} 6-20 mg/l, 24-96h exposure
Daphnia magna (water flea)	EC_{50} 1.5-2.1 mg/l, 24-48h exposure
Pseudomonas fluorescens	5 g/l

Table 8: Exotoxicity of Preventol O extra, the active ingredient in Preventol OF

Biodegradability	
Closed bottle test (OECD 301D)	biodegrades easily
Biological oxygen demand	50-60% after 5 days 60-70% after 10 days 70-80% after 20 days

Minimal test in an inoculated mineral solution and organic medium test in the presence of activated sludge:

After 3 weeks' adaptation of the medium, OPP is degraded completely.

In the presence of activated sludge	complete degradation within 2 days

Table 9: Ecotoxicity of Preventol O extra, the active ingredient in Preventol OF

Minimum inhibitory concentrations in nutrient agar (mg/l)

Micro-organisms	MIC in mg/l
Alternaria alternata	200
Aspergillus niger ATCC 10575	10
Aureobasidium pullulans ATCC 9348	35
Cephaloascus fragrans	5
Ceratocystis pilifera	20
Chaetomium globosum ATCC 6205	15
Cladosporium cladosporioides	50
Gliocladium virens	75
Penicillium glaucum	15
Phialophora fastigiata	50
Sclerophoma pityophila	5
Trichoderma viride	1000

Preventol A8 is not effective enough to satisfy the requirements of DIN EN 152. part 1. Combination with the blue-stain fungicide reventol A4-S is recommended.

Table 10

Toxicology

Acute toxicity:

LD_{50} oral (male rat):	> 5000 mg/kg(*)
LD_{50} oral (female rat):	- 3900 mg/kg
LD_{50} dermal (rat):	> 5000 mg/kg(*)

(*) No death occurred at this dose

LC_{50} Inhalation; rat (4h):	> 818 mg/m³ (**)
LC_{50} Inhalation; rat (5 x 6h):	> 240 mg/m³ (**)

(**) Maximum technically feasible concentration using dynamic aerosol production

Skin irritation (rabbit):
after 4 h exposure no primary irritation was observed

Eyes (rabbit):
not irritant

Sensitization:
The Magnusson-Kligman maximization test as well as the B0hler patch test in guinea pigs revealed no evidence of sensitizing properties.

Subacute toxicity:
Sub-chronic, chronic, oncogenicity and reproduction studies in rats, mice, dogs and rabbits show, that Tebuconazole proved to be a safe chemical under normal use conditions. Lack of mutagenicity effects are demonstrated by several in-vitro and in-vivo studies.

Table 11

Ecotoxicity

Toxicity in fish:

LC_{50} (Leuciscus idus):	8.7 mg/l (96h exposure)
LC_{50} (Salmo gairdneri):	4.4 mg/l (96h exposure)

Toxicity in Daphnia magna:

EC_{50}:	25 mg/l (24h exposure)
EC_{50}:	11.8 mg/l (48h exposure)

Toxicity against algae:
NOEC (Scanedesmus subspicatus): 1.0 mg/l
NOEC = No observed effect concentration

Table 12

LF2: A New Antisapstain Active Ingredient and Product

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Plant Pathologist

Safer Ltd.

Safer's Research and Development group at Victoria have identified a new antisapstain active called LF2. In all, 262 compounds were screened in a tiered bioassay system. LF2 was selected on the basis of safety, longevity of activity, cost effectiveness and a lack of wood discoloration.

The LF2 results of a 4-month field trial at Forintek (Tables 1 and 2) demonstrated a level of protection comparable to TCMTB on hemlock-fir and spruce-pine-fir boards. The identity and application rates of LF2 are not being disclosed at this time.

Table 1. Forintek Efficacy Field Test 1990: Number of Clean Boards

Treatment	Retention	Acceptable Boards (%)**	
		Hemlock-Fir	Spruce-Pine-Fir
LF2	2.0 X	100%	99%
LF2	1.5 X	99%	96%
LF2	1.0 X	93%	95%
TCMTB	0.75 g/m^2	100%	85%
TCMTB	0.50 g/m^2*	99%	58%
TCMTB	0.25 g/m^2	96%	65%
Water Control		36%	0%

* recommended rate

** In Forintek tests a product is considered effective when a minimum of 90% of boards are acceptable

Table 2. Forintek Efficacy Field Test 1990: Rating Method

Treatment	Retention	Average Rating (0 to 5)	
		Hemlock-Fir	Spruce-Pine -Fir
LF2	2.0 X	0.1	1.1
LF2	1.5 X	0.3	1.0
LF2	1.0 X	0.8	1.1
TCMTB	0.75 g/m^2	0.2	1.4
TCMTB	0.50 g/m^2*	0.5	2.3
TCMTB	0.25 g/m^2	0.7	2.0
Water Control		2.9	4.9

* recommended rate

The active compound of LF2 has been used for several decades in a wide range of applications. These include detergents, paper and cloth making, agricultural pesticides, shampoos and hair conditioners, hand and face lotions, and pharmaceutical tablets. It is also used in foods such as cocoa, evaporated milk, cold packed cheese foods, cream cheese, French dressing, and food colouring solutions.

LF2 has a low overall toxicity. Its toxicity to rainbow trout is 75 ppm.

Safer has patents pending in several countries on the use of LF2 on lumber to control fungi.

In summary, LF2 is a major breakthrough in antisapstain fungicides. It has a well established toxicological data base, and has been used for several decades in detergents, hand and face lotions and foods.

STA-BRITES A AND P

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Chapman Chemical Company

Abstract

The Sta-Brite System was developed by Chapman Chemical Company as a major innovation to sapstain or blue stain control. The use of this formulation and the active ingredients soluble therein represent new, innovative technology indicating a strong lead in the third generation of sapstain control chemicals since the early 1930's.

Sta-Brite P, one of the products in the Sta-Brite System utilizing polyphase as the active ingredient, represents a unique system for dispersing and distributing extremely low molecular levels of the active ingredient throughout the surface of the wood, providing adequate protection of fresh-cut lumber from sapstain and also incorporating corrosion inhibitors, buffering agents, and dispersants in a non-acidic system. Sta-Brite P has gained large recognition in the North American timber treatment market as one of the safest, most economical treatments for the prevention of sapstain in fresh-cut lumber and timbers.

Key Words: Wood preservation, sapstain, blue stain, polyphase, Sta-Brite.

Background

Since the 1930's, sawmills and sawmill operators have searched for chemicals which would prevent sapstain or blue stain from infecting fresh-cut lumber and timbers. Original work on broad-spectrum compounds proved to be effective; however, long-term and short-term effects on man and the environment will strongly limit the use of broad-spectrum fungicides in the future.

Sodium pentachlorophenate and sodium tetrachlorophenate have been widely used for the prevention of sapstain and blue stain for over six decades. Second-generation products containing oxine copper, TCMTB, methylene bisthiocyanate, or quaternary ammonium compounds, proved to be the next broad step in sapstain control with minimal environmental impact. Use of these second-generation compounds also found the sawmill operator having to use buffering agents, corrosion inhibitors, stainless steel equipment, or exposed workers to undue hazards while handling either the concentrates or the fresh-made solutions.

Research at Chapman Chemical Company, a leader in wood preservation for over five decades, generated new formula-specific systems for dissolving fungicides which would give adequate sapstain control. As toxicity packages continue to increase, the registration of a

new fungicide in today's marketplace will cost in excess of $30 million. Therefore, the number of active fungicides which can be distributed and used for sapstain control are extremely limited under both Environment Canada, Ag Canada, and the U.S. EPA system. Therefore, a system for using currently available registered materials and dispersing these in a proprietary system which would give the best distribution throughout the surface of the lumber was investigated. The result of that investigation is currently known as the Sta-Brite System.

Product Chemistry

The Sta-Brite System consists of an organic solvent, a cationic and nonionic dispersant system, a corrosion inhibitor, a built-in buffering agent, and a biologically active fungicide. The use of the Sta-Brite System allows many commercially available fungicides (i.e., polyphase, azaconazole, sodium orthophenylphenate, propiconzaole, etc.) to be effectively utilized in the Sta-Brite System. The Sta-Brite System allows uniform distribution of the biologically active compound throughout the solution and/or the surface of the wood by effectively dispersing the fungicide into almost molecule-size particles and allowing these to effectively coat the surface of the wood, preventing further inoculation or hyphe-penetration through the protective envelope.

Although several registrations are currently pending, Sta-Brite P, which utilizes 6% polyphase (3-iodo-2-propynyl butyl carbamate) currently has registrations in several countries, including the U.S., and pending registrations in Canada, several other biologically active compounds are being evaluated in sawmills around the world. With new, third-generation chemicals being available based on substituted triazole chemistry or other proprietary chemistry, narrow spectrums of control and resistance to certain organisms may be inevitable. This is another reason that the Sta-Brite System is of extreme importance because this system is as key to sapstain control as the biologically active compound is itself. In addition, when second-generation chemicals containing certain acidic media and quaternary ammonium compounds, particularly chlorides, were introduced into the market several years ago, iron stain and iron tannate became a serious problem with lumber prices being degraded rapidly when chain marks, lift marks, and inky blue stains from iron tannate became even more noticeable with the phase-out of alkaline systems which formerly utilized pentachlorophenate or its salts.

Chapman attributes much of the success of Sta-Brite P in the States to the fact that the product contains buffering agents, corrosion inhibitors, and effective dispersants, packaged in one system.

Field Trials and Test Results

During 1990, over 41 large-scale trials at sawmills all over North America were performed, using 13 different biocide or co-biocide systems, including Sta-Brite P (6% polyphase) and Sta-Brite A (2% azaconazole). In these 41 sawmills and four research laboratories located at different universities including Oregon State University, Michigan Tech University, Mississippi State University, and Virginia Tech University, as well as Forintek, the Sta-Brite System proved to be effective on all species tested, including Doug-fir, hemlock, true fir, SPF, oak, hackberry, gum, pine, elm, beech, and poplar. Of critical importance to the B.C. market is the effectiveness of the Sta-Brite System on SPF, hem-fir, and Douglas-fir.

Adequate protection was obtained using Sta-Brite A and Sta-Brite P on western species. However, when large-scale field tests began to be evaluated, it was noted that certain types of polyphase systems, including those containing other active co-biocides, had an effectively high HLB balance which coupled in organics, bark, and iron tannate, which would effectively deactivate the polyphase system and alter the absorption kinetics of the product, which would tend to make the product lose effectiveness. Chapman reviewed all of the available data on this phenomena and determined one of the principal causes of the deactivation of polyphase-containing systems to be the water soluble extractives and iron tannate in solution. For this reason, in large-scale bulk dip vats, a product known as Bulk Tank Brightener was also developed.

Bulk Tank Brightener

Bulk Tank Brightener is an effective additive to polyphase-containing systems which can be used to effectively coagulate and precipitate out organics, bark, and iron tannate from solutions which may deactivate or lower the effectiveness of polyphase-containing systems. Bulk Tank Brightener is essentially similar to the Sta-Brite System; however, ratios of the cationic and nonionic dispersant system have been altered where this system can no longer couple into the solution the tannates, the organics, and the extractives which can effectively bind to the fungicide, reducing its effectiveness.

Use of Bulk Tank Brightener in large bulk dip vats, coupled with an effective circulation and filtration system, can extend the useful service life of many polyphase-containing systems at a fraction of the cost of what fortifying these systems with more active ingredients will cost. Bulk Tank Brightener can be used as a maintenance item for large-scale bulk dip vats or may be utilized one-to-one with Sta-Brites in the Sta-Brite System to help provide adequate, long-term protection (4 to 12 months) of fresh-cut timber from blue stain.

Organisms Controlled

Blue stain organisms from the 41 field trials, as well as from the laboratory evaluations, were characterized and identified. Organisms adequately controlled, using Sta-Brite P, include penicillium, trichoderma, ceratysistis, phialophora, aspergillis, and other fungi imperfecti.

Environmental Impact and Toxicity

One of the principal reasons for developing Sta-Brite Systems and Sta-Brite P was a thorough review of the chemistry and toxicological properties of the existing products available to control sapstain in fresh-cut lumber. Many products containing polyphase, quaternary ammonium chlorides, TCMTB, methylene bisthiocyanate, and sodium salts of pentachlorophenol adequately control sapstain in fresh-cut lumber. However, their toxicity profile is less than to be desired.

For a brief time period, Chapman Chemical Company marketed a product known as Chapco SA-1. Chapco SA-1 (essentially similar to NP-1) contained 7.6% 3-iodo-2-propynyl butyl carbamate and 64.8% didecyldimethyl ammonium chloride (DDAC). Chapman marketed this product until patents issued on the product, but during the marketing of this product, Chapman noticed that physical handling properties of this product, as well as selective distribution and absorption of this compound and deactivation of the polyphase component of the formulation, coupled with the corrosivity of a chloride compound and the environmental impact of using chlorinated hydrocarbons, were less than to be desired. In addition to this, Chapman has also marketed formulations containing MBT and TCMTB in the past under the name Mitrol T-109 and Mitrol T-1030. Worker exposure to these compounds caused severe sensitization, rash, and complaints.

Chapman reviewed all of the existing toxicity on the currently available products from our acute toxicity test, as well as publications known as the Capco Note, published by Ag Canada and Environment Canada, to determine relative toxicities which needed to be overcome. Development of the Sta-Brite System, which yielded lower toxicities - dermally, inhalation, and aquatic - as well as negative sensitization studies, as compared to positive results for all other formulations tested (see chart, Figure 1, for results) yielded the Sta-Brite System.

The Sta-Brite System is also a system which represents less worker exposure to toxic compounds and other commercially available materials. Because the effective dispersant system in the Sta-Brite System allows lower levels of active ingredient to be used and disseminated, less tons of active pesticides are spread throughout the environment, which will eventually find their way into the ecosystem. In addition to this, lower toxicity to humans around spray systems and ultra low-volume sprayers is minimized by the low toxicity of the Sta-Brite System. One of the most significant issues concerning the Sta-Brite

System and particularly Sta-Brite P is that when LC-50's were run on rainbow trout, the Sta-Brite P product proved to be one of the least toxic in terms of aquatic toxicity of any product tested.

Summary and Conclusions

Sta-Brite P, the cornerstone of the Sta-Brite System which currently has registrations in many countries including the U.S.A.., has pending registration in Canada. Sta-Brite P effectively controls sapstain and blue stain on all commercial species tested, especially those essential to the British Columbia market. Sta-Brite P, with its low toxicity profile as compared to other commercially available products, represents one of the newest, most innovative technologies available in third-generation sapstain control chemicals in the market today. These benefits, coupled with one-third the toxicity of other commercially available products, brighter lumber, ease of handling, adequate quality control measures, and overall safety to the worker and to the environment, make Sta-Brite P one of the most innovative, cost-effective, useful products for sapstain control available today.

For further information or complete toxicity data base and product literature, contact Chapman Chemical Company, P.O. Box 9158, 416 E. Brooks Rd., Memphis, TN, USA, 38109-0158, phone 901/396-5151.

RODEWOD 300 SC-TU

Mike Freeman — **Chapman Chemical Company**

Tom Woods — **SK Biotech**

Rodewod 300 SC-TU is a aqueous flowable formulation, developed for sapstain control by Janssen Pharmaceutica (Belgium), containing a mixture of 150 g/l azaconazole plus 150 g/l chlorothalonil. The formulation is being tested and developed by ISK Biotech Corporation (Mentor, OH) and by Chapman Chemical Co. (Memphis, TN).

The properties and biological activities of azaconazole and chlorothalonil as wood preservatives were discussed in the Proceedings of the American Wood Preservers' Association for 1985 and 1990, respectively. Both active ingredients have excellent toxicological profiles. As a fungicide of the triazole class, azaconazole possesses excellent activity against a variety of fungi causing blue stain. The outstanding strength of chlorothalonil is an inhibitor of mold fungi. Together, the two active ingredients show considerable potential in controlling the major fungi involved in the etiology of the sapstain disease complex in freshly sawn lumber and debarked logs.

A trial of the efficacy of Rodewod 300 SC-TU was conducted in 1990 by Forintek Canada Corp. Freshly sawn, unseasoned, ungraded, untreated lumber (hem-fir, Douglas-fir, or S-P-F) was treated with fungicides at the rate of 25 ml per square meter of board surface. Busan 1030 was used as a commercial control treatment. After chemical treatment, boards were inoculated with a mixture of stain and mold fungi, after which boards were piled and wrapped for long-term incubation and storage. Test packages were dismantled and inspected after four months and evaluated for defacement caused by stain, mold, and decay, and for general % acceptability. Results of acceptability ratings are shown in Tables 1-3. A fungicide treatment was rated as satisfactory if 90% of the boards were rated as acceptable.

On hem-fir, none of the Rodewod 300 SC-TU treatments gave satisfactory control (90% acceptable or above). The staining fungi were the prevalent group on the Rodewod-treated boards and there was no visible growth of mold or decay fungi.

On Douglas-fir, Rodewod 300 SC-TU gave satisfactory performance at all treatment rates. Again, only staining fungi were significant on the Rodewod-treated boards. With Busan 1030, 3.0% a.i. was required to provide satisfactory control.

On S-P-F, the two highest rates of Rodewod 300 SC-TU gave satisfactory control. At the lowest rate, degrade was caused mainly by staining fungi. All rates of TCMTB gave unsatisfactory control on S-P-F.

Table 1. Four-month evaluation by Forintek of the performance of Rodewod 300 SC-TU and Busan 1030 in preventing fungal deterioration on hem-fir.

TREATMENT	% ACCEPTABLE
BUSAN 1030WP 1% A.I.	96
BUSAN 1030WP 2% A.I.	99
BUSAN 1030WP 3% A.I.	100
RODEWOD 300 SC-TU 1:40 + BORAX 2.5%	78
RODEWOD 300 SC-TU 1:20 + BORAX 2.5%	75
RODEWOD 300 SC-TU 1:10 + BORAX 2.5%	86
CONTROL	36

Table 2. Four-month evaluation by Forintek of the performance of Rodewod 300 SC-TU and Busan 1030 in preventing fungal deterioration on Douglas-fir.

TREATMENT	% ACCEPTABLE
BUSAN 1030WP 1% A.I.	56
BUSAN 1030WP 2% A.I.	71
BUSAN 1030WP 3% A.I.	100
RODEWOD 300 SC-TU 1:40 + BORAX 2.5%	99
RODEWOD 300 SC-TU 1:20 + BORAX 2.5%	99
RODEWOD 300 SC-TU 1:10 + BORAX 2.5%	89
CONTROL	33

Table 3. Four-month evaluation by Forintek of the performance of Rodewod 300 SC-TU and Busan 1030 in preventing fungal deterioration on spruce-pine-fir (S-P-F).

TREATMENT	% ACCEPTABLE
BUSAN 1030WP 1% A.I.	65
BUSAN 1030WP 2% A.I.	58
BUSAN 1030WP 3% A.I.	85
RODEWOD 300 SC-TU 1:40 + BORAX 2.5%	79
RODEWOD 300 SC-TU 1:20 + BORAX 2.5%	91
RODEWOD 300 SC-TU 1:10 + BORAX 2.5%	89
CONTROL	0

A small-scale field trial was initiated in September 1990 at Mississippi State University, to evaluate the performance of Rodewod 300 SC-TU in controlling sapstain on pine, oak, sweetgum, and poplar. In this experiment, boards were chemically treated but were not artificially inoculated. After two months, boards were rated for defacement on a scale of 0-5, with 0 representing complete control of fungal growth and a 5 indicating no control. Results are shown in Table 4.

Table 4. Evaluation of Rodewod 300 SC-TU by Mississippi State University for sapstain control on pine, oak, sweetgum, and poplar boards 60 days after fungicide treatment.

TREATMENT	PINE	OAK	SWEETGUM	POPLAR
CONTROL #1	4.38	1.56	1.31	3.44
CONTROL #2	5.00	3.31	4.25	4.50
CONTROL #3	5.00	1.75	3.88	3.81
BUSAN 1009	2.19	0.56	1.19	0.44
RODEWOD 1:100	3.13	0.94	0.63	0.38
RODEWOD 1:200	3.06	0.69	0.38	1.44

Trial initiation: 9-26-91
Rating Scale: 0-5

Although results in the Mississippi State University trial are quite variable, they do indicate that the performance of Rodewod 300 SC-TU is comparable to that of a commercial standard, in this case Busan 1009.

APPENDIX A
LIST OF SPEAKERS

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APPENDIX B
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